वार्षिक प्रतिवेदन
ANNUAL REPORT
2009-10

वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद्

सीएसआईआर-प्रगत पदार्थ तथा प्रक्रम अनुसंधान संस्थान

CSIR - Advanced Materials and Processes Research Institute

एम्प्री ampri CSIR-AMPRI

वार्षिक प्रतिवेदन
2009-10

Published by
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Director, CSIR-AMPRI, Bhopal

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From the Director's Desk

I am extremely delighted to present the Annual Report of the CSIR-Advanced Materials and Processes Research Institute, Bhopal for the year 2009-10. For me this period is a significant one, as the institute is under repositioning after its name change from Regional Research Laboratory to Advanced Materials and Processes Research Institute. The repositioning and reengineering of a R&D institute is an important and vital journey and needs sustainable efforts.

The most immediate concerns are identifying niche areas according to its recent name change and providing necessary infrastructural facilities to build the image of this institute. To take up the first initiative, efforts were put to immediately organize a Research Council Meeting, which couldn`t take place from past two years. It was the 35^{th} Research Council meeting, where Chairman and Members of the Research Council made important recommendations that the name change of the institute has a great potential to develop products and technologies pertaining to lightweight materials and it is the right time that CSIR-AMPRI should carryout brain storming sessions to focus on few important areas/projects. Taking this into concern, we have conducted a series of brain storming sessions on Light Weight Materials, Smart Materials, Building Materials and Nano Materials and consolidated our expertise for Strategic, Societal, Industry oriented and In-house innovations. Our ultimate aim is to develop innovative products/components along with industry for their successful commercialization. With this Mantra, we are planning our future strategies and preparing a road map of AMPRI for taking up sustainable initiatives which will be a way forward for us during 12^{th} Five Year Plan.

On the R&D infrastructure front, a Centralized Materials Characterization Laboratory has been setup in CSIR-AMPRI to facilitate Materials Characterization activities like hardness testing, micro structural analysis, thermal and physical analysis of various engineering materials at a single place. These equipments were previously kept at different places leading to difficulty in operation and maintenance. Further the utilization efficiency of the equipment has gone up. During last one year, the institute is equipped with the state-of-the-art facilities viz., Universal Testing Machine (up to 600°C), Vickers Hardness Tester (50 kg), Impact Tester (-50 to 150°C), Universal Fiber Testing Machine, Universal Macro Hardness Tester, High Temperature Viscometer (Max.1000°C), High Temperature Contact Angle Measuring Device, Thermal Conductivity Meter, Thermal Analyser, Nano Imprint Lithography, Pin on disc Sliding Wear Testing Machine, Magnesium Melting Furnace, Horizontal Cold Chamber

Pressure Die-Casting facility, Ultrasonic Vibrator, Liquid Nitrogen Plant and CNC Turn Mill Centre. To make the institute a promising materials characterization and processing center, efforts are being made to procure Field Emission Scanning Electron Microscope (FESEM) with features like ESD and EBSD for in-depth characterization studies.

The institute was started in May 1981 as “Regional Research Laboratory” (RRL) and is situated in the current premises which was originally built to accommodate a Co-operative Training College. The present infrastructure is not in a position to cater the R&D needs of the institute. Taking this into concern, we have prepared a Master Plan which will help in identifying the priorities and organized planning of infrastructure of the institute. The newly constructed main entrance road has been widened and plantation work has been taken along the pavement. Apart from this, the whole campus needs ambience improvement. We have initially taken up the job around the institute and later spread the same to the whole campus. The most important thing to mention here is that after the ambience improvement of the campus landscaping was done in all the areas and plantation/horticulture activities have been carried out in association with Central Institute of Agricultural Engineering (CIAE) and Forest Department of Govt. of Madhya Pradesh.

The present manpower includes 47 scientists (against the sanctioned strength of 56) that are well trained in different disciplines of materials science and other related areas along with 86 supporting staff. The number of scientists is planned to increase in the near future in view of the widened range of R&D activities. The overall objective of AMPRI is to achieve a world-class status in the area of engineering materials, component and process development. Accordingly, the HR Profile and S&T infrastructure would address to the needs of fundamental and applied research, technology development and business development in the area of materials of the future. During the last one year, six JTA`s and twenty project assistants have been recruited and the recruitment of scientists is under process.

Without having industry-institute interactions engineering laboratories could not produce sustainable and innovative products. CSIR-AMPRI being placed under Engineering Science Cluster, it is very much essential to focus on product/component development where industry should be involved right from the beginning. Taking this into concern, we have organized two Institute-Industry meets on wood substitutes and lightweight materials to bring synergy between CSIR-AMPRI and the Industry for enhancing and deepening Public-Private Partnership. In Wood substitutes, our institute has expertise and we would like to upgrade this technology for product innovation and explore the possibility for technology transfer and commercialization. CSIR-AMPRI has established its expertise in the areas of Material Characterization, Processing, Simulation and Modeling since long time. In the Eleventh Five Year Plan, the institute is operating a major Network Project on lightweight metallic materials for advanced engineering applications. The institute-industry meet on light weight materials was organized with an aim to involve the industry right from the development of components/products till their commercialization. Eaton Corporation, M/s. Shivam Autotech Ltd, Hero Group of Industries, General Motors R&D, Aeronautical Development Agency (ADA), Ashok Leyland, Tata Motors and Eicher Group attended the meeting. All these agencies have proposed to take up short, medium and long term projects with CSIR-AMPRI. Apart from this a road map of lightweight materials research is being prepared for working on a consortium mode in the 12th Five Year Plan.

From the Director's Desk

CSIR-AMPRI has made sustained efforts to excel in terms of research publications and patents. The SCI publications have been increased from 32 (2008) to 48 (2009) and ratio per scientist is ~ 1. Twelve scientists were deputed for foreign visits, eleven scientists attended CSIR Leadership Program (LDP) and twenty three staff members were sent for other trainings. The institute carried out various activities aimed at enriching research and work environment through a large number of invited lectures and inhouse seminars. The institute hosted the visits of Prof. S.K. Joshi, former DG, CSIR during CSIR Foundation Day – 2009 , Prof. Vinod K. Singh, Director, IISER, Bhopal during Technology Day – 2009 and Dr. Krishan Lal, Former Director, NPL during National Science Day 2010.

We are experiencing many positive changes in the CSIR under the dynamic leadership of Prof. Samir K. Brahmachari, DG, CSIR. This is the right time and opportunity that we must look at how CSIR-AMPRI may contribute to national challenges. If CSIR-AMPRI has to come forward as a major force in technology development, many changes are still required as we have to align ourselves in line with demand from industry and maintain the pace of research based on current standards and anticipate future needs. I am sure that the CSIR-AMPRI family will stand up to the expectations and meet these challenges.

I take this opportunity to gratefully acknowledge the guidance and support from Prof. Samir K. Brahmachari, DG, CSIR and Dr. G. Sundararajan, Chairman, RC and distinguished members of the Research Council who are constantly helping in repositioning this important institute. I also wish to place on record the unstinted support from my staff who are continuously putting untiring efforts to position this institute as a prestigeous institute on Materials Research.

(Anil K. Gupta)
Director, CSIR-AMPRI

Date : March 25, 2011

निदेशक की कलम से

मुझे सी.एस.आई.आर. प्रगत पदार्थ तथा प्रक्रम अनुसंधान संस्थान, भोपाल का वर्ष 2009-10 का वार्षिक प्रतिवेदन प्रस्तुत करते हुए हार्दिक प्रसन्नता हो रही है। मेरे लिए यह अवधि महत्वपूर्ण है क्योंकि संस्थान क्षेत्रीय अनुसंधान प्रयोगशाला से प्रगत पदार्थ तथा प्रक्रम अनुसंधान संस्थान के रूप में नाम परिवर्तन के बाद अपने आपको पुनर्स्थापित कर रहा है। किसी अनुसंधान एवं विकास संस्थान की पुनर्स्थापना और पुनर्संरचना एक महत्वपूर्ण और जीवंत यात्रा होती है और इसके लिए निरंतर प्रयासों की आवश्यकता होती है।

नाम परितर्वन के तुरंत बाद का विचार नाम परिवर्तन के अनुसार महत्वपूर्ण कार्य क्षेत्रों की पहचान और संस्थान की छवि बनाने के लिए आवश्यक आधारसंरचनात्मक सुविधाएं प्रदान करना है। प्रथम चरण के रूप में अनुसंधान परिषद् की बैठक अविलंब आयोजित करवाई गई, जो कि पिछले दो वर्षों से आयोजित नहीं हो पा रही थी। 35वीं अनुसंधान परिषद् की बैठक में अनुसंधान परिषद् के अध्यक्ष एवं सदस्यों ने यह महत्वपूर्ण अनुशंसा की, कि संस्थान के नाम परिवर्तन से संस्थान में प्रगत पदार्थों से संबंधित उत्पाद तथा प्रौद्योगिकियाँ विकसित करने की अधिक संभावनाएँ दिखाई देती हैं और यही सही समय है कि एम्प्री को कुछ महत्वपूर्ण क्षेत्रों/परियोजनाओं पर ध्यान केन्द्रित करने हेतु विचार मंथन करना चाहिए। इस बात को ध्यान में रखते हुए हमने अल्पभार पदार्थों, स्मार्ट पदार्थों, भवन निर्माण सामग्री तथा नैनो पदार्थों पर कुछ विचार मंथन सत्र आयोजित किए और अपनी विशेषज्ञता को रणनीतिपरक, सामाजिक, औद्योगिक तथा आंतरिक नवाचारों के लिए संकलित किया। हमारा अंतिम ध्येय उद्योगों के साथ मिलकर नवाचारी उत्पाद/घटक विकसित करना है, जिसका सफलतापूर्वक व्यवसायीकरण किया जा सके। इस मंत्र के साथ हम अपनी भविष्य की रणनीति की योजना और सतत प्रयासों के प्रारंभ करने हेतु एम्प्री के लिए एक योजना तैयार कर रहे हैं, जो बारहवीं पंचवर्षीय योजना के उद्देश्यों के कार्यान्वयन की दिशा में हमारा एक चरण होगा।

अनुसंधान एवं विकास आधारसंरचना के क्षेत्र में सी.एस.आई.आर.-एम्प्री में एक ही स्थान पर विभिन्न अभियांत्रिकीय पदार्थों के कठोरता परीक्षण, सूक्ष्म संरचना विश्लेषण, ताप एवं भौतिक विश्लेषण जैसे पदार्थ अभिलक्षणन कार्यों के लिए एक केन्द्रीकृत पदार्थ अभिलक्षणन प्रयोगशाला स्थापित की गयी है। ये उपस्कर पूर्व में पृथक-पृथक स्थानों पर रखे थे, जिससे कि उनके परिचालन तथा रख-रखाव में कठिनाई आती थी। इसके अतिरिक्त इन उपस्करों की प्रयोग कुशलता में भी वृद्धि हुई है। पिछले एक वर्ष में संस्थान में अति उत्कृष्ट सुविधाएँ- यूनिवर्सल टेस्टिंग मशीन (600^0 से. तक), विकर्स हार्डनेस टेस्टर (50 कि.ग्रा.), इम्पैक्ट टेस्टर (-50 से 150^0 से.), यूनिवर्सल फाइबर टेस्टिंग मशीन, यूनिवर्सल मैक्रो हार्डनेस टेस्टर, हाइ टेम्परेचर विस्कोमीटर (अधिकतम 1000^0 से.), हाइ टेम्परेचर कॉन्टेक्ट एंगल मेजरिंग डिवाइस, थर्मल कंडक्टिविटी मीटर, थर्मल एनालायजर, नैनो इम्प्रिंट लिथोग्राफी,

पिन ऑन डिस्क स्लाइडिंग वियर टेस्टिंग मशीन, मैग्नीशियम मेल्टिंग फर्नेस, हॉरिजोन्टल कोल्ड चैम्बर प्रेशर डाइ कास्टिंग फेसिलिटी, अल्ट्रासोनिक वाइब्रेटर, लिक्विड नाइट्रोजन प्लांट एवं सी.एन.सी. टर्न मिल सेन्टर। संस्थान को एक विश्वसनीय पदार्थ अभिलक्षणन एवं प्रसंस्करण केन्द्र के रूप में स्थापित करने के लिए गहन अभिलक्षणन अध्ययन हेतु ई.एस.डी. तथा ई.बी.एस.डी. सुविधा के साथ फील्ड एमिशन स्कैनिंग इलेक्ट्रॉन माइक्रोस्कोप क्रय करने के प्रयास चल रहे हैं।

संस्थान मई, 1981 में क्षेत्रीय अनुसंधान प्रयोगशाला (आर.आर.एल.) के नाम से प्रांरभ हुआ था और यह जिस परिसर में स्थित है वह वास्तव में एक कोऑपरेटिव प्रशिक्षण महाविद्यालय का भवन था। वर्तमान आधारसंरचना संस्थान की अनुसंधान एवं विकास आवश्यकताओं को पूरा करने में सक्षम नहीं है। इसे ध्यान में रखते हुए हमने एक मास्टर प्लान बनाया, जिससे प्राथमिकताएं तय करने और संस्थान की आधारसंरचना की योजना तैयार करने में सहायता मिलेगी। नवनिर्मित मुख्य प्रवेश सड़क को चौड़ा किया गया और पेवमेन्ट के साथ-साथ वृक्षारोपण किया जा रहा है। इसके अतिरिक्त सम्पूर्ण परिसर को परिवेश विकास की आवश्यकता है। हमने प्रारंभ में यह कार्य संस्थान के आस-पास प्रारंभ किया था पर धीरे-धीरे हमने इसे पूरे परिसर में विस्तार दिया है। यहाँ उल्लेख करने हेतु सबसे महत्वपूर्ण बिन्दु यह है कि परिसर के परिवेश विकास के बाद केन्द्रीय कृषि अभियांत्रिकी संस्थान तथा वन विभाग, म.प्र. शासन के सहयोग से लैंडस्केपिंग की गई और वृक्षारोपण/बागवानी का कार्य किया गया।

संस्थान में पदार्थ विज्ञान एवं अन्य संबंधित क्षेत्रों में प्रशिक्षित 47 वैज्ञानिक (स्वीकृत 56 पदों के विरुद्ध) तथा 86 सहयोगी स्टाफ कार्यरत हैं। अनुसंधान एवं विकास गतिविधियों के विस्तार को देखते हुए निकट भविष्य में वैज्ञानिकों की संख्या बढ़ाई जाने की योजना है। एम्प्री का समग्र लक्ष्य अभियांत्रिकी पदार्थों, प्रक्रम एवं घटक विकास के क्षेत्र में विश्वस्तरीय स्थान प्राप्त करना है। इसी के अनुरूप संस्थान का मानव संसाधन प्रोफाइल एवं विज्ञान तथा प्रौद्योगिकी आधारसंरचना भी भविष्य के पदार्थों के क्षेत्र में बुनियादी एवं अनुप्रयुक्त अनुसंधान, प्रौद्योगिकी विकास तथा व्यवसाय विकास की आवश्यकताओं को पूरा करने का प्रयास करेगा। पिछले एक वर्ष में 20 परियोजना सहायकों तथा 6 कनिष्ठ तकनीकी सहायकों समूह -III (1) की भर्ती की गई और वैज्ञानिकों की भर्ती की प्रक्रिया चल रही है।

उद्योग - अनुसंधान अंतर्सम्पर्क के बिना हम सतत एवं नवाचारी उत्पादों का विकास नहीं कर सकते। सी.एस.आई.आर.-एम्प्री अभियांत्रिकी विज्ञान क्लस्टर में है अतः यह बहुत ही महत्वपूर्ण है कि उत्पाद/घटक विकास पर ध्यान केन्द्रित किया जाए जिसमें कि उद्योग प्रारंभ से ही भागीदार हों। यह ध्यान में रखते हुए हमने काष्ठ विकल्प तथा अल्पभार पदार्थों पर दो संस्थान- उद्योग बैठकों का आयोजन किया। इन बैठकों के आयोजन का उद्देश्य सार्वजनिक-निजी भागीदारी में वृद्धि के लिए एम्प्री और उद्योगों के बीच समन्वय स्थापित करना था। काष्ठ विकल्प के क्षेत्र में हमारे संस्थान की विशेषज्ञता है और हम इस प्रौद्योगिकी का उत्पाद विकास के लिए उन्नयन करना तथा व्यवसायीकरण एवं प्रौद्योगिकी हस्तांतरण के लिए संभावनाएँ तलाश करना चाहते हैं। सी.एस.आई.आर.-एम्प्री ने लम्बे समय से पदार्थ अभिलक्षणन, प्रसंस्करण, अनुकरण एवं प्रतिरूपण के क्षेत्रों में विशेषज्ञता हासिल की है। ग्यारहवीं पंचवर्षीय योजना में संस्थान द्वारा प्रगत अभियांत्रिकीय अनुप्रयोगों हेतु अल्पभार धात्विक पदार्थों के संबंध में महत्वपूर्ण नेटवर्क परियोजनाओं पर कार्य चल रहा है। अल्पभार पदार्थों पर आयोजित उद्योग-अनुसंधान बैठक का उद्देश्य उद्योगों को घटकों/उत्पादों के विकास से लेकर उनके व्यवसायीकरण तक जोड़ना है। इस बैठक में ईटन कार्पोरेशन, मेसर्स शिवम ऑटोटेक लिमिटेड, हीरो ग्रुप ऑफ इंडस्ट्रीज, जनरल मोटर्स अनुसंधान एवं विकास, एरोनॉटिकल डेवलपमेंट एजेंसी, अशोक लीलैंड, टाटा मोटर्स एवं आयशर समूह ने बैठक में हिस्सा लिया। इन सभी एजेंसियों ने सी.एस.आई.आर.-एम्प्री के साथ लघु, मध्यम एवं लंबी अवधि की परियोजनाओं पर कार्य करने का प्रस्ताव किया है। इसके अतिरिक्त 12वीं पंचवर्षीय योजना में संघ के रूप में कार्य करने के लिए एक अल्पभार पदार्थ अनुसंधान योजना तैयार की जा रही है।

सी.एस.आई.आर.-एम्प्री ने अनुसंधान प्रकाशनों एवं पेटेंट्स की दृष्टि से उत्कृष्ट कार्य करने के लिए निरंतर प्रयास किए हैं। एस.सी.आई. प्रकाशन 32 (2008) से बढ़कर 48 (2009) हो गए हैं और प्रति वैज्ञानिक इनका अनुपात ~1 हो गया है। 12 वैज्ञानिक विदेश प्रतिनियुक्ति पर गए, 11 ने सी.एस.आई.आर. नेतृत्व विकास कार्यक्रम (एल.डी.पी.) में हिस्सा लिया और 23 स्टाफ सदस्यों को अन्य प्रशिक्षणों पर भेजा गया। संस्थान द्वारा बड़ी संस्था में आमंत्रित व्याख्यानों तथा आंतरिक संगोष्ठियों के माध्यम से अनुसंधान तथा कार्य परिवेश के विकास के उद्देश्य से अनेक गतिविधियाँ आयोजित की गयीं। संस्थान का सौभाग्य है कि सी.एस.आई.आर. स्थापना दिवस- 2009 के अवसर पर प्रो. एस.के. जोशी, पूर्व महानिदेशक, सी.एस.आई.आर., राष्ट्रीय विज्ञान दिवस-2010 के अवसर पर डॉ. किशनलाल, पूर्व निदेशक, राष्ट्रीय भौतिकी प्रयोगशाला तथा प्रौद्योगिकी दिवस-2009 के अवसर पर प्रो. विनोद कुमार सिंह, निदेशक, विज्ञान शिक्षा एवं अनुसंधान संस्थान, भोपाल मुख्य अतिथि थे।

हम प्रो. समीर के. ब्रह्मचारी, महानिदेशक, सी.एस.आई.आर. के नेतृत्व में अनेक सकारात्मक परिवर्तन देख रहे हैं। यही सही समय है कि हम यह देखें कि सी.एस.आई.आर.-एम्प्री राष्ट्रीय चुनौतियों का सामना करने में किस प्रकार सहयोग करता है। यदि सी.एस.आई.आर.-एम्प्री को प्रौद्योगिकी विकास के क्षेत्र में एक बड़ी ताकत बनकर सामने आना है तो अभी भी कई परिवर्तन लाने होंगे क्योंकि हमें भविष्य की आवश्यकताओं की पहले से अपेक्षा करते हुए वर्तमान मानकों पर आधारित अनुसंधान की गति बनाए रखते हुए तथा उद्योगों की माँग को ध्यान में रखते हुए कार्य करना होगा। मुझे विश्वास है कि सी.एस.आई.आर.-एम्प्री परिवार अपेक्षाओं पर खरा उतरेगा और इन चुनौतियों का सामना करेगा।

मैं प्रो. समीर के. ब्रह्मचारी, महानिदेशक, सी.एस.आई.आर.; डॉ. जी. सुंदरराजन, अध्यक्ष, अनुसंधान परिषद् तथा अनुसंधान परिषद् के सम्माननीय सदस्यों का उनके द्वारा दिए गए मार्गदर्शन एवं सहयोग के लिए आभार व्यक्त करना चाहता हूँ, जिनका सहयोग हमें संस्थान की पुनर्स्थापना में निरंतर मिल रहा है। मैं अपने स्टॉफ के सहयोग को भी रेखांकित करना चाहूँगा, जिनके अथक प्रयासों से यह संस्थान एक प्रतिष्ठित पदार्थ अनुसंधान संस्थान बना है।

अनिल गुप्ता

अनिल कुमार गुप्ता
निदेशक, सी.एस.आई.आर.-एम्प्री

दिनाँक : 25 मार्च, 2011

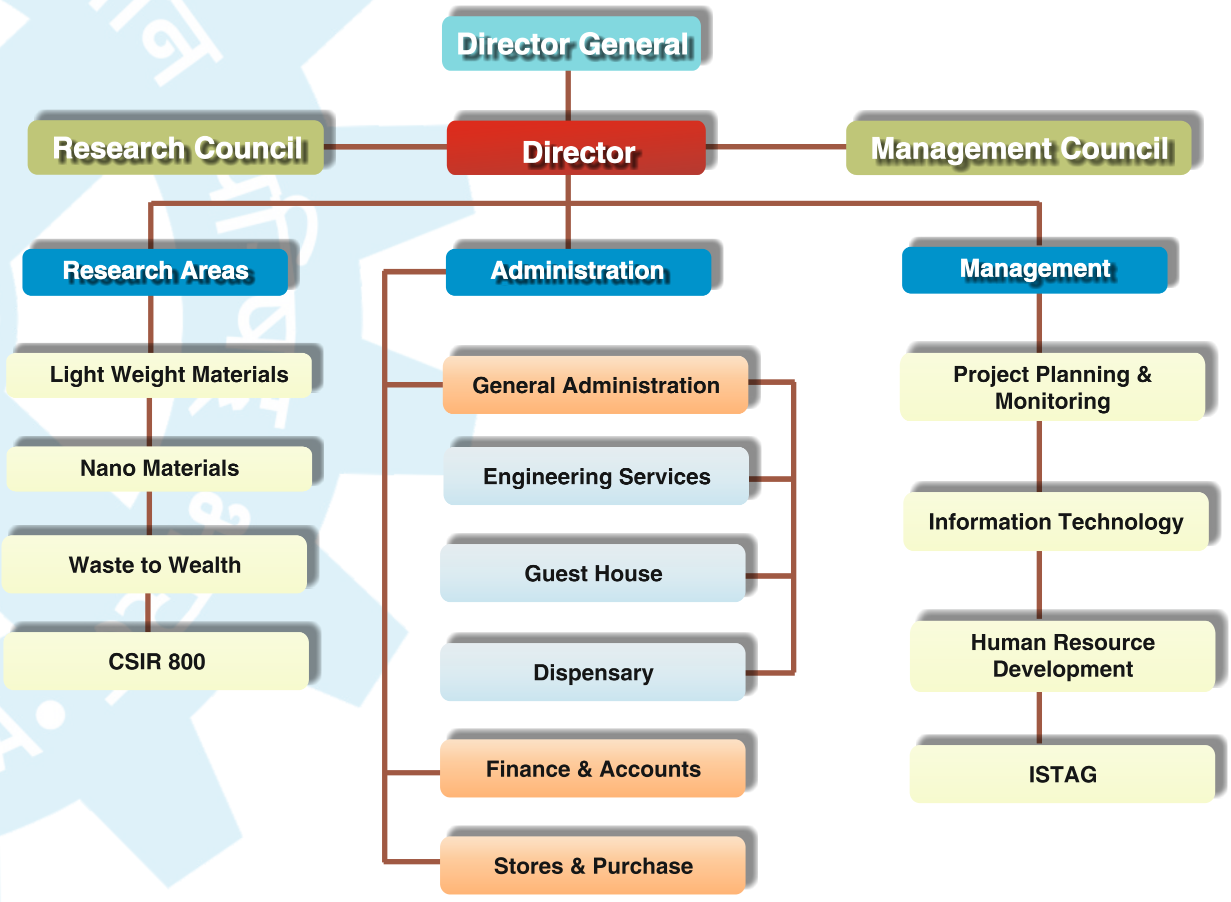
VISION

CSIR-AMPRI, Bhopal is committed to develop innovative, cutting edge, internationally competitive, energy efficient and environmental friendly technologies/products in the area of advanced materials for societal benefits and to contribute to the Nation's Economy.

Mandate

- Research & Development on Engineering Materials for Strategic, High Performance and Societal Applications
- Materials, Processes and Technology Development for Component/Products for a variety of engineering materials, including Metals & Alloys, Composites, Polymers, Building Materials and materials from Waste to Wealth
- To undertake consultancy, sponsored, grant-in-aid, network & other national, international projects for both public and private sectors in above areas

ORGANIZATION CHART



Research & Development REPORT

एम्प्री
ampri
CSIR-AMPRI

An overview of the CSIR-AMPRI R&D Activities

CSIR-AMPRI is engaged in the development of lightweight materials, building materials, natural fibers and materials from industrial wastes. R&D expertise of AMPRI lies in the areas of material synthesis, processing and characterization supported by computer simulation & modeling studies. Significant progress has been made in the area of light weight materials, such as aluminium and magnesium based alloys, metal matrix composites, metallic foams, polymers, natural fibres, nanomaterials, shielding materials etc. The name change from Regional Research Laboratory (RRL) to Advanced Materials and Processes Research Institute (CSIR-AMPRI) provided challenging opportunity to set up new programs for the development of cutting-edge technologies and deliver cost-effective, green and energy efficient technologies. AMPRI is placed under Engineering Sciences Cluster and has a mandate to carry out R&D in engineering materials for strategic, high performance and societal applications. During the period of reporting, a series of brain storming sessions were conducted to identify niche areas in composites, foams, smart materials and nanomaterials. Greater emphasis is being given to commercialization of already developed technologies of the institute like Brake Drum, Radiation Shielding Materials etc.

The institute has an excellent combination of R&D expertise which works for the high end engineering applications and in the same time also working for the under privileged communities. The institute carried out work on various rural development and dissemination activities related to CSIR-800 with emphasis on contributing to rural sector through transfer of technologies.

Major activities carried out under the CSIR eleventh five year plan projects and other significant achievements are summarized in subsequent sections.

Lightweight Materials

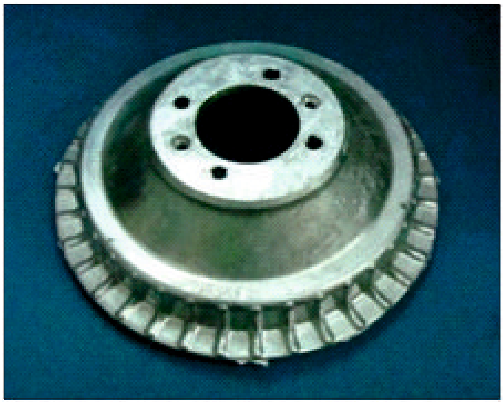
Development of Advanced Lightweight Metallic Materials for Engineering Applications

Development of lightweight high performance metallic materials for engineering applications in various sectors like automobile, aerospace, defense and general engineering is one of the major thrust of this project. Emphasis is being given for the development of materials like Al/Mg alloys, ultra fine particle reinforced aluminum matrix composites, aluminum foam with uniform cell size and distribution. Facilities have been developed to prepare magnesium alloys under protective atmosphere with an aim to develop materials with improved strength and creep resistance. The facilities for developing ultrafine particle reinforced Al MMCs through ultrasonic vibration, pressure die-casting, semisolid processing etc. have been added. Secondary processing like rolling with hot and cold rolling facilities have already been setup for processing of Al and Mg alloys and their composites. Deformation processing maps for a series of Al alloys, and Al composites have been established which could be used for efficient secondary processing of these materials.

All these facilities are being developed to make Al MMC brake drums, Al foam filled crash boxes, Al foam filled bracket, and sandwich panels, Mg alloy etc. Interactions have been made with automobile industries for the development of Al foam components. Studies on aluminium syntactic foam synthesized by stir casting technique were carried out by AMPRI. Properties of closed cell Al foam with finer size pores were evaluated for crash worthiness applications. The Al alloy foam is produced inside the mild steel channels. These channels are further joined and the bracket is made for noise and vibration attenuation for application in automobile sector. Foam core density varied between 0.3-0.6 g/cc.

Foam Filled Crash Box

MMC Brakedrum - 300 mm dia



Brakedrum - 150 mm dia

Extrusion of Al-Composites

Successful attempts were made to extude Al-alloy based composites made with fine SiC particle (size between 10-20 micron). The extruded rods at extrusion ratio 10:1 and 15:1 have been characterized for metallographic, mechanical, sliding wear and hardness properties.

Die Designing and Fabrication

A number of extrusion dies for extruding to rods, tubes in different shapes like cylindrical, square and rectangular have been designed and fabricated. These have been heat treated and later tested for workability using Al-alloys for extrusion. These dies will serve as a basic infrastructure for extruding other alloys and composites synthesized at AMPRI, Bhopal.

Forgeability Studies for Aluminium Alloy Based Composite

Al-alloys and composites synthesized have been investigated for their forgeability and the forged samples characterized for microstructure, sliding wear and hardness properties to compare with the cast and extruded materials. Further an attempt has been made to predict the forgeability of an Al-alloy and verification by actual experimentation.

Development of Pulsed Electromagnetic Welding Technique for Refractory Materials Used in High Temperature Reactors

The main objective of this activity is to establish the optimum parameters of joining plates and tubes of Ti-Zr alloy used for reactors using pulse power technique and assessing their quality through metallographic investigations of the joints. The project has been sponsored by the Board of Research in Nuclear Sciences [BRNS]. The project is being carried out with AMPRI, Bhopal and BARC, Mumbai as collaborators. Preliminary samples have been joined electromagnetically at BARC, Mumbai and investigations related to joining is being presently investigated.

Comparison of Processing Route and the Material for Producing Cost Effective Spider Key Bar Profile With Improved Property

The spider key bar is an integral part of the hydrogenerator assembly presently fabricated through machining of thick plates. The spider key bar is specially strengthened at the lower end of the outer periphery to carry the weight of the rim and poles. The lower end is designed as a short cantilever subjected to bending. At present the strengthening of lower end of spider key bar is achieved by taking a thick bar and machining its entire length except lower lip. In this process a lot of scrap is generated. Suggesting an alternate method of strengthening and comparing the two methods especially from the strength aspect is the basic aim of the project.

The suggested alternate method is to build up the lower lip by weld deposit, during fabrication stage (i.e. before stress relieving). Commonly used welding methodology and materials can not be adopted for building up of the lip, however superior quality weld material under optimised parameters can successfully build up the lip.

Due to implications of testing such component and non-standard type of testing, much thought has been focused for designing of the fixtures/holders. Final adoptable system will designed after real trial. Scaling down (1: 6) of the dimension for real testing seems to be difficult as it results in lip of 5 mm. Suitable dimensions have been selected for the study. The experimental work is in progress after initial simulation study of the life size actual component.

Institute-Industry Meet on Lightweight Material Development

Lightweight materials are preferred substitutes for traditional materials. These novel materials help automotive manufacturers increase fuel efficiency and reduce the emission of harmful pollutants, without compromising on performance, size, and utility. AMPRI, Bhopal is committed to development of advanced materials and processes that offer advantages of being cost effective, environmental friendly and energy efficient. AMPRI has developed a commendable expertise in the areas of Material Processing, Characterization, Simulation and Modeling. In the Eleventh Five Year Plan the institute is leading and implementing a CSIR network project on Lightweight Metallic materials for advanced engineering applications. With a view to bring together industry, user agencies from automobile and aerospace sectors to map technological opportunities in lightweight materials AMPRI organized an institute-industry meet on March 18, 2010.

Senior executives from automobile and aerospace sectors were invited to attend this meeting. Representatives from Eaton India Engineering, M/s. Shivam Autotech Ltd, Hero Group of Industries, General Motors R&D, Aeronautical Development Agency (ADA), Ashok Leyland, Tata Motors and Eicher Motors participated in the deliberations.

Dr. Anil K. Gupta, Director, AMPRI, Bhopal welcomed the delegates and said that the objective of the meet was to initiate sustainable interactions with the industry. He expressed confidence that the interaction meet would eventually facilitate preparation of a national road map for light weight materials research and it will be implemented during CSIR 12th Five Year Plan Program. In his detailed presentation Dr. Gupta gave a panoramic view of R&D capabilities and achievements of AMPRI in the area of light weight materials particularly, metal matrix composites, metallic foams, natural fibres and polymer composites. He informed that AMPRI possessed processing capabilities such as pressure die casting and rolling of aluminum alloys and would soon develop similar expertise in magnesium alloys. The processing capabilities are backed with a strong computer simulation and modeling capability. He hoped that the present industry interaction meet would help to identify opportunities in component development based on pressure die casting, sheet forming, extrusion, hydro-forming in consultation with user agency i.e., automobile and aerospace sectors.

All the participating agencies have proposed to take up short, medium and long term projects with AMPRI in the areas of MMC brake drums, crash box natural fiber panels, metallic foams (ferrous and nonferrous), magnesium housing and cylinder blocks, aluminum and magnesium components for engine valve trains.

Institute-Industry Meet on Lightweight Materials

Waste to Wealth

Wood Substitutes

In the area of Waste to Wealth, the institute has largely worked on the utilization of flyash and red mud. The institute has developed wood substitute's technology using redmud, flyash and natural fiber. The composites developed are of high strength, corrosion resistant and can be processed at room temperature. The technology developed was named as R-Wood Technology and has potential applications for making doors, panels, partitions and furniture.

Institute-Industry Meet on Wood Substitutes

CSIR-Advanced Materials and Processes Research Institute (AMPRI), has developed a wood substitute technology. In this aspect, a one day programme on Institute-Industry Meet on Wood Substitute Technology was organized on February 22, 2010 at AMPRI Bhopal to explore the possibility for technology transfer and commercialization of Wood Substitutes developed by the institute. Around fifty delegates attended the program. The participants were from different industries, agencies and promoters involved in building materials, policy making authorities, officials from different organizations like CPWD, Housing Board, Bhopal Development Authorities etc., from Madhya Pradesh Maharashtra, Chhatisgarh and New Delhi. At the outset, Dr. Anil K. Gupta, Director AMPRI addressed the gathering and highlighted significance of the wood substitute products developed by the institute. He informed that AMPRI would conduct a series of institute-industry interaction meetings to promote awareness on available technologies and the current meeting was the first in the series. He briefly described R&D activities of AMPRI, particularly those in the areas of alternate building materials and components based on natural fibres and industrial wastes, such as, fly ash and red mud.

Dr. Shailesh Kr Agrawal, Executive Director, BMTPC, Ministry of Urban Affairs and Poverty Alleviation, Government of India, New Delhi briefly highlighted upon the demand of wood in construction industry in India and the importance of manufacturing alternative for wood so that deforestation and various environmental problems can be resolved. He opined that the wood substitute technology developed by AMPRI Bhopal had potential applications in building industry.

During the meet, an exhibition was arranged in which various wood substitute products were displayed. All the participants visited the exhibits and had detailed discussion with AMPRI scientists on various aspects of products quality and related applications. A visit to the Technology Enabling Centre (TEC) was also arranged where the details of making of wood substitute products and required machineries was explained to all the participants. All the participants evinced keen interest in the wood substitute technology and various R&D activities of AMPRI.

Institute-Industry Meet on Wood Substitutes

Radiation Shielding Materials

AMPRI has developed a new material and novel process for making effective shielding phases utilizing red mud and fly ash for making advanced new radiopac materials. The shielding efficiency of these radiopac materials was evaluated by Radiation Standards and Safety System Division of BARC, and Atomic Energy Regulatory Board (AERB), Mumbai. The HVT (half value thickness) i.e. shielding thickness of the materials developed by AMPRI materials is as thin as Lead for Diagnostic X-ray of 100kV and 60% less in comparison to conventionally used concrete for gamma radiations.

In the second phase, a project on development of γ-ray shielding materials in collaboration with Nuclear Power Corporation of India Limited (NPCIL) was undertaken and the results indicated that the HVT of the developed material is 60% of cement-concrete shielding material used currently for such applications. Further work is in progress and exploratory work has been initiated for development of neutron as well as EMI shielding materials.

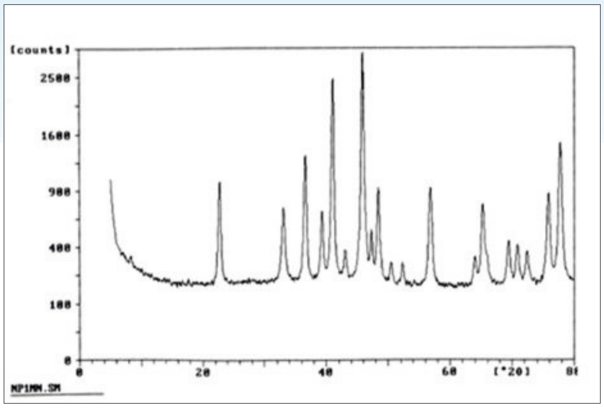
Nano Materials

AMPRI has been working on the development of various nanomaterials and powders. The institute has carried out synthesis and characterization of inorganic nanopowders through chemical routes such as controlled precipitation, sol-gel and emulsion routes for engineering applications (Mn_2O_3-MnOOH, TiC, SiC, ZrO_2 etc).

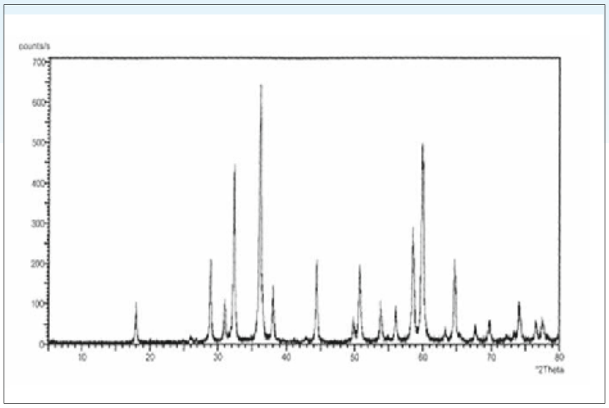
Synthesis of nano sized Mn_2O_3-MnOOH and TiC

Manganese bearing nano sized powder was synthesized using controlled precipitation technique in the presence of a surface active agent. Rod shaped MnOOH and spherical Mn_2O_3 particles were obtained. MnOOH rods could be converted to oxide phase by application of small energy such as by ultrasonication. Manganese oxide finds applications as a catalyst for several chemical reactions.

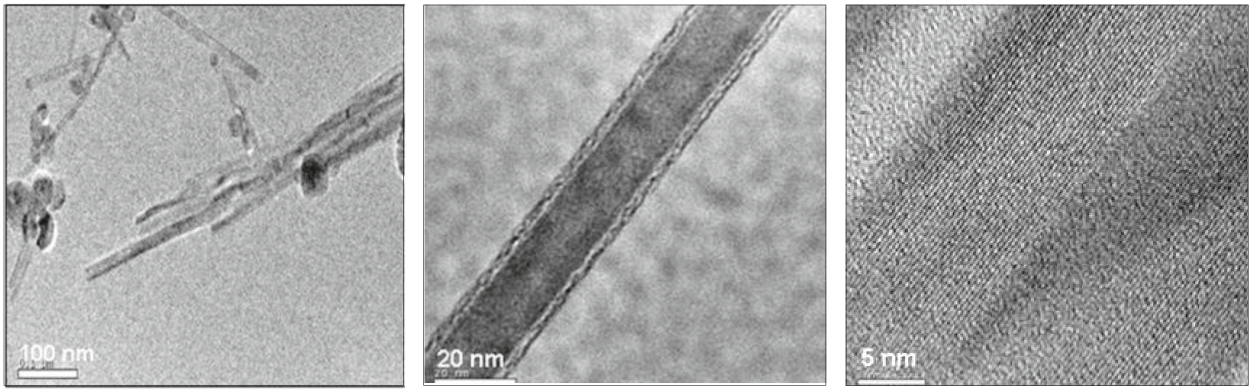
For the synthesis of nano-sized titanium carbide, a novel process was adopted where in titanium bearing gel and nano-carbon particles derived from soot were reacted at different temperatures (1300-1580°C) to obtain hollow rods and cube shaped particles of TiC. Titanium carbide is a hard material and is widely used as abrasive material.



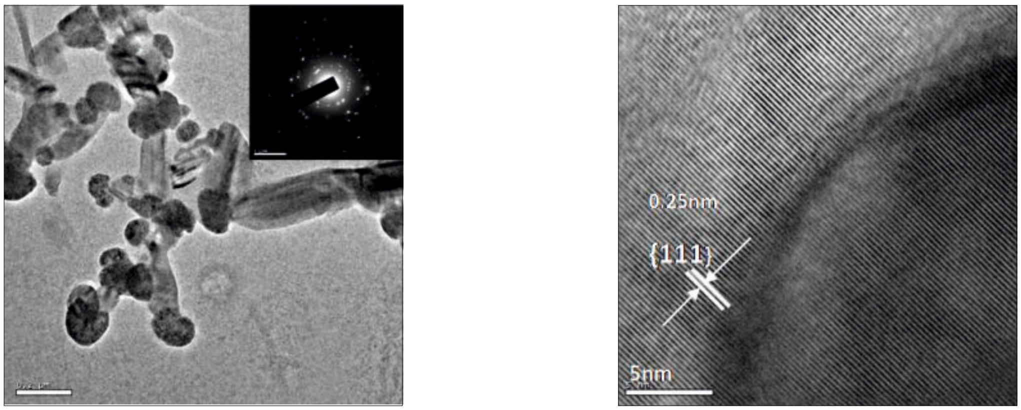
X-ray Diffractogram of nano size sample showing the presence of Mn_2O_3 and MnOOH phase



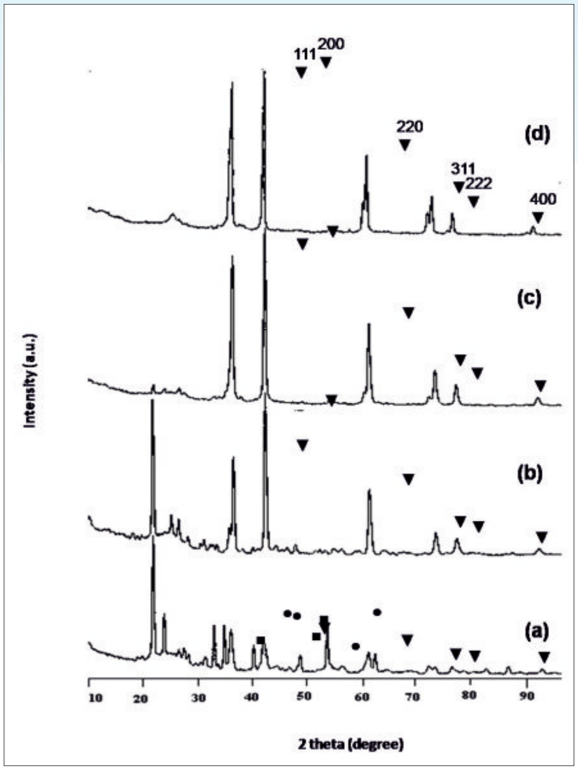
X-ray Diffractogram of aceton dispersed nano size sample showing the presence of Mn_2O_3 phase



HRTEM images of MnOOH nanoroads and Mn_2O_3 nanoparticles



HRTEM images of titanium carbide synthesized at 1580°C.
Inset shows selected area diffraction Pattern and TiC particle at higher magnification



XRD pattern of the samples obtained by firing titanium precursor with nano size carbon particles under argon at different temperatures: (a) 1300°C (b) 1400°C (c) 1500°C (d) 1580°C. The phases present are: (▼) TiC, (■) Ti_4O_7 and (●) Ti_2O_3.

Development of Aluminium and Copper-based Nano Composite Materials

Nanostructured aluminium and copper-based nano composite materials produced by (a) in-situ casting route followed by cryogenic rolling/ forging and (b) powder metallurgy route (cryo and / or high energy milling, compaction followed by microwave/ vacuum) leads to the development of superior mechanical, thermal and tribological properties. Preliminary work carried out on cast in-situ Cu-TiC composite, Al-TiB_2 composite and Cu-TiC (P/M route) has exhibited microstructure consisting of ultra fine (upto 5 μm) ceramic particles with improved properties. The current work involves synthesis of Cu-TiC composites by powder metallurgy route involving milling, compaction and vacuum sintering followed by characterization.

Wear Performance Evaluation of Ni-Ti Based Shape Memory Alloys and Composite under Sliding and Cavitation-Erosion Conditions

CSIR-AMPRI has characterized the Ni- Ti based shape memory (Ni-Ti-Cu and Ni-Ti-Fe) alloys and Ti-Ni TiC composites developed by BARC with a view to assess their suitability for wear related applications involving cavitation-erosion and sliding wear and to understand the material removal mechanisms under cavitation erosion and sliding modes of wear. The wear response of a Ti-47Ni-3Fe shape memory alloy in sliding mode of wear under varying speeds (1.0-6.25 m/sec) and applied pressures (1-10 MPa) has been carried out. Friction coefficient and temperature rise during sliding were monitored in addition to the wear rate. Pressure (P) - Velocity (V) limit has been determined for the alloy in dry and partially lubricated conditions to see the safe working regime. The wear rate increased with pressure and velocity whereas friction coefficient and frictional heating were affected by the parameters in a mixed manner. The SEM examination of wear surfaces, sub-surfaces and debris were carried out to understand the mechanism of material removal during sliding.

Nanomaterials and Nanodevices in Health and Disease

The objective of this activity is separation of biomolecules using micro/ nano fluidics and development of lab-on-a-chip device for analysis of neurotransmitters. A simple straight channel design has been tested and multimers of λ-DNA has been separated successfully about 30 times faster than conventional pulsed field gel electrophoresis. Microfluidics channels have been tested for rapid determination of sulfonamides in milk using micellar electro kinetic chromatography with fluorescence detection. Validation of micro fluidic channel has been carried by surface treatment of silica channels with polymer coatings for the separation of bio molecules. Basic proteins have been separated by capillary electrophoresis using capillary coated with poly-vinyl alcohol. Biogenic amines have been separated by micellar electrokinetic chromatography with fluorescence detection after derivatization with fluorescamine.

CSIR 800

Sisal Potential for Rural Development and Green Technologies

Sisal is considered to be promising natural fiber out of all available natural fibers because of its strength, durability, and ability to stretch, affinity for dyeing and resistance to weather conditions. Sisal is a plant fiber obtained from its long knife-shaped leaves which is primarily used for the production of ropes, anchors and handicrafts. The yarn and textile made out of this fiber is used for making composites for applications in sectors like housing, automobile, geotextiles, etc. The tremendous potential of sisal as a resource has not so far been exploited in India for value addition and employment generation in rural and semi-urban sectors. Preliminary investigations indicate that there is a great potential for the development of sisal based technologies for rural and engineering applications.

AMPRI carried out work on sisal fiber technologies to evolve know-how, processes, technologies, machinery and products on a mission mode approach for creating sustainable employment in rural areas. The major objectives of the project are:

- Development of improved methods of sisal fiber extraction for industrial applications,
- Processing and Characterization of sisal fibres for yarn and textile making,
- Development of various prototype viz., building materials, instant house, buffing wheel, fishing boat and geo-textiles.

AMPRI made efforts in improving the efficiency of sisal fiber extraction machine by rigid fixing of cutting blades for lower damage of fibers, non-swirling action for uniform and continuous fiber extraction and dual leaf operation capability for higher fiber production and lower energy consumption.

In the subsequent sections significant findings of R&D works of AMPRI are presented.

Significant
R&D Achievements

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CSIR-AMPRI

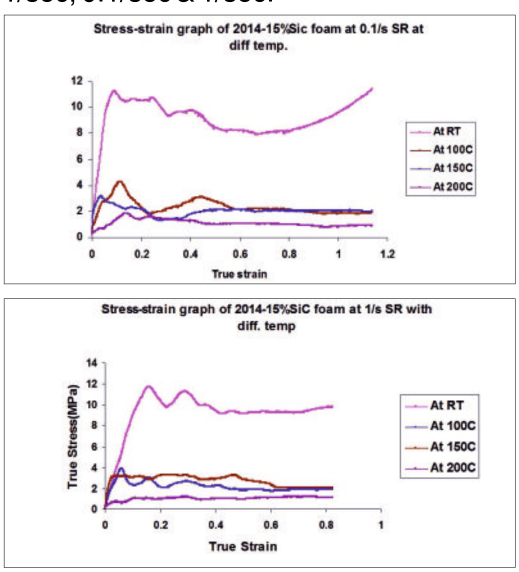
Compressive Deformation Behaviour of Aluminium Composite Foam

Metal foam is known for its excellent combination of physical, mechanical, damping and thermal management properties. It sustains sudden impact and able to convert much of its impact energy into the plastic energy and absorbs more energy than a bulk material. Because of these interesting combination of properties, it is used as a high-energy absorbing material in crash protectors, packaging, door panel, front hood, bumpers, roof panels, bonnets and body frame element etc. One of the most important applications of Al composite foam is in automobile crash box for crashworthiness.

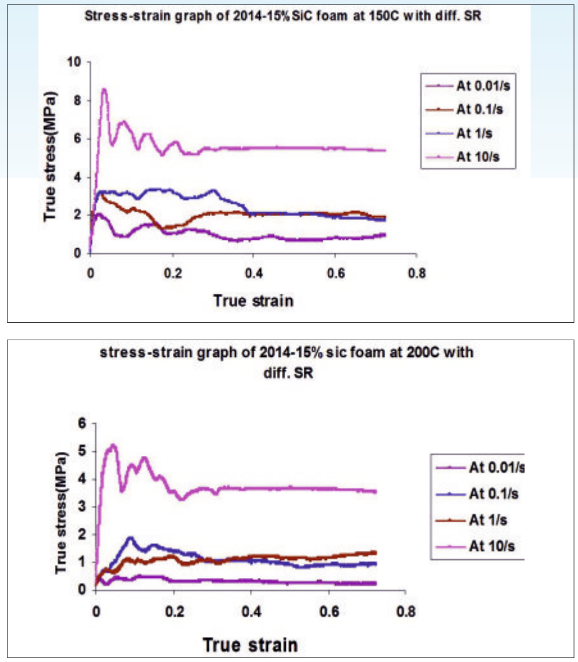
The properties of the foam were as below:

Relative density	:	0.1-0.3
Size of pore	:	1-2 mm
Cell wall thickness	:	200-300μm
Energy absorption	:	4-7 Mj/m^3
Modulus	:	4-5 GPa
Plateau Stress	:	10-12 MPa

The samples of aluminium composite foam were subjected to compression test at temperatures RT, 100°C, 150°C, & 200°C and at strain rates of 0.01/sec, 0.1/sec & 1/sec.

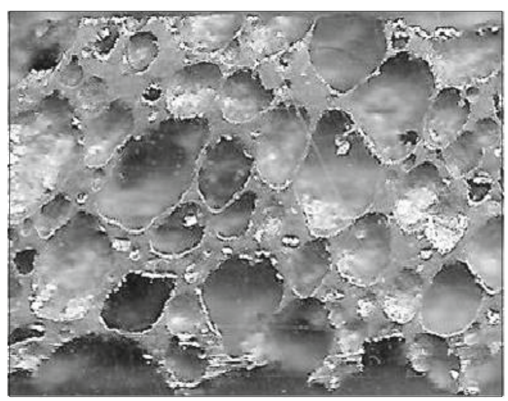


(a) Effect of Temperature



(b) Effect of Strain Rate

True stress - True strain diagram of Al foam :
(a) Effect of Temperature (b) Effect of Strain Rate



Al-SiC Foam

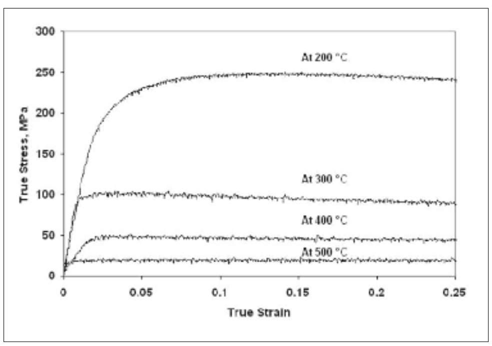
Increasing the temperature reduced the plateau stresses because of softening of metallic matrix. Strain rate enhanced the plateau stress. At RT, plateau stress decreased at high strain rate. And at 100°C plateau stress constant with strain rate. Further at 150-200°C plateau stress increased at high strain rate.

Compressive Deformation Behaviour of 2014 -10wt.% SiCp Composite

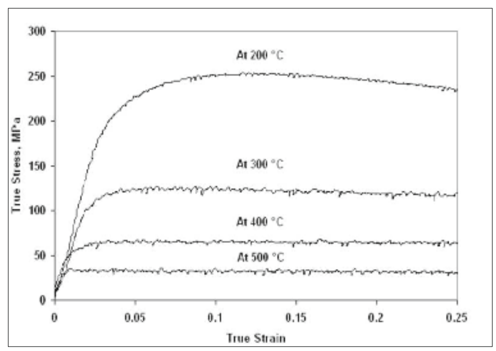
The compressive deformation behaviour of aluminium composites containing 10wt.% SiC particles (size: 20-40μm), in homogenized condition were tested at different strain rates (0.01/sec to 10/sec) and at different temperatures of 200°C, 300°C, 400°C and 500 °C. The objective of this study was to understand the hot deformation behaviour of AA2014 alloy in presence of SiC particle dispersion. The flow stress and Zener-Holloman parameter of Al composites were evaluated and hot deformation mechanism was studied.

Homogenized samples were machined for compression test with dimensions of 10 mm diameter and 15 mm length. The samples were subjected to compression test at temperature of 200°C, 300°C, 400°C & 500°C at strain rates of 0.01/sec, 0.1/sec, 1/sec & 10/sec. The samples were homogenized for 300 seconds at each set temperature, before the compression test.

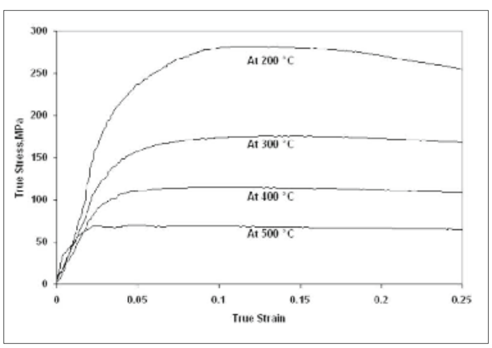
It was observed that the flow stress is represented by a ZenerHolloman parameter (Z) in the hyperbolic-sine equation. It is observed that Z is decreasing with deformation temperature and increasing with strain rate. The activation energy for hot deformation is decreased with strain rate upto values of 1/sec, and then increased at a strain rate of 10/sec.. This phenomenon is observed in all set of test temperatures. It indicates that at higher strain rates, above 1/sec, Al composites might not be suitable for hot deformation. The deformed microstructure exhibited elongated grains of ductile Al and $CuAl_2$



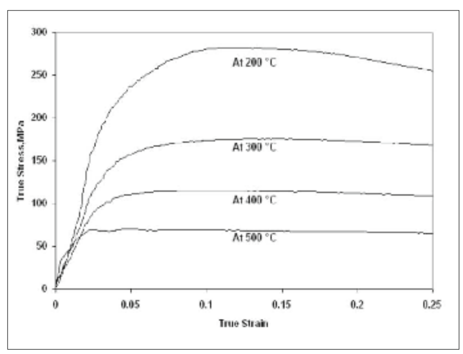
(a) *0.01/Sec*



0.1/Sec (b)



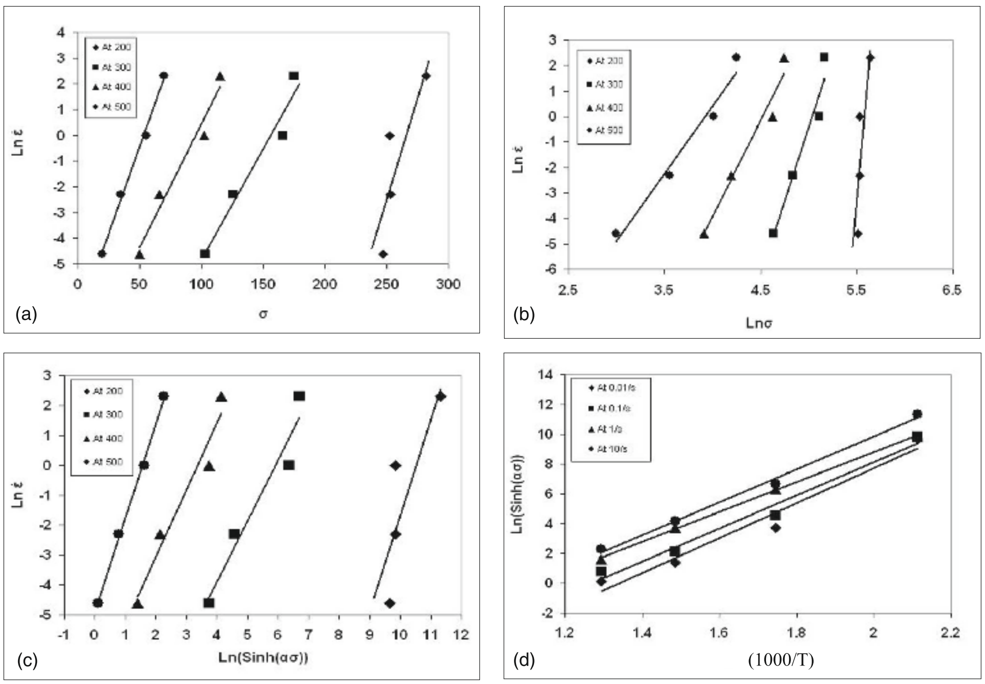
(c) *1/Sec*



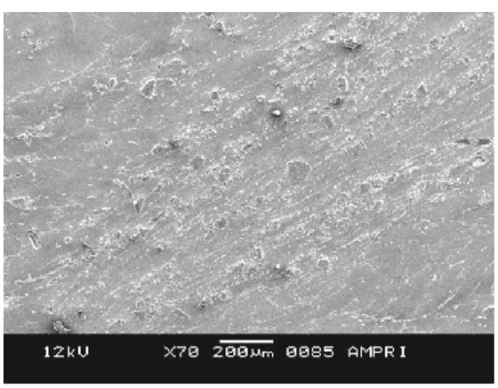
10/Sec (d)

True stress - True strain diagram of AA2014 - 10 wt.% SiCp composite
Tested at different temperatures and at a strain rate of (a) 0.01s^{-1}, (b) 0.1s^{-1}, (c) 1s^{-1}, (d) 10s^{-1}

phase along the grain boundaries. The ductile Al grains elongated in the direction perpendicular to the direction of compression. During deformation process, the load transferred from matrix towards the hard SiC particles. The dispersed SiC particles engulfed with Al and flows along with the Al matrix.

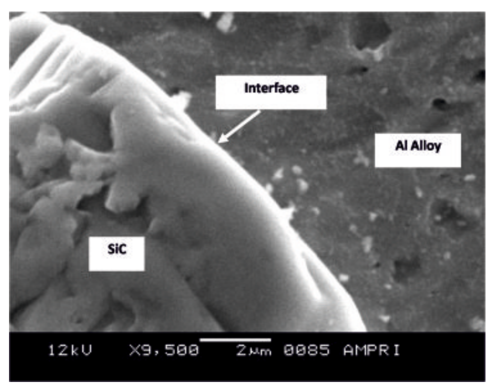


Relationship among peak stress, strain rate and temperature during deformation
a : σ - Lnε b : σ lnε - in c: ln [Sinh (ασ)] - lnε D : 1000/T⁻ ln [Sinh (ασ)]



Flow of grains

SEM micrograph of Al 2014-10wt.% SiC particle composite showing distribution of SiC particles and elongated Al grains (Temperature : 200^0C; Strain rate : 10/sec).



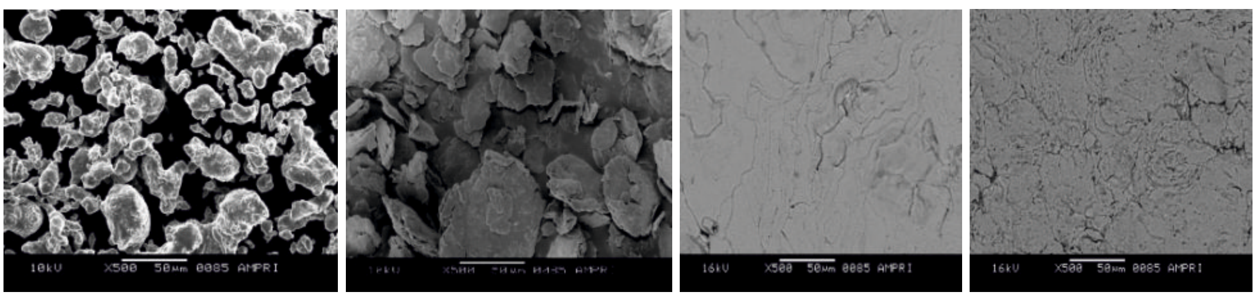
Interface

Micrograph showing the interface bonding.

Sintering Behaviour of Cryo-milled Aluminium Powder

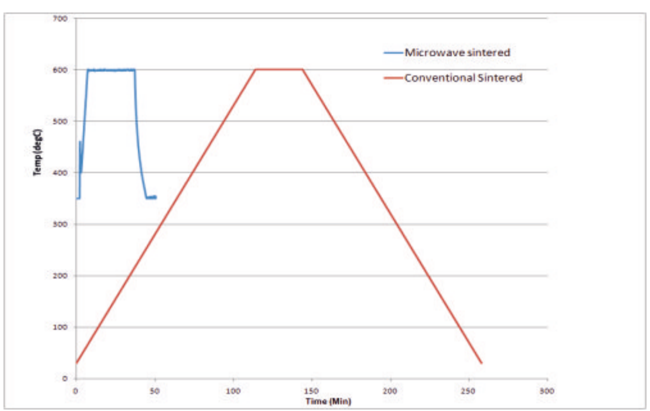
Mechanical Milling, especially milling under Cryogenic condition is an effective approach to synthesize large quantity of Nanocrystalline Metallic Powder. Compaction and sintering studies of cryo-milled Aluminum Powder were carried out. Pure Al Powder was milled in Liquid Nitrogen slurry (Ball to Powder ratio: 32:1) for 1 hr and Compaction of the Milled powder was done at 500 MPa. Sintering in Conventional Furnace at 600 ^{0}C for 30 min. at N_2 atmosphere (Heating rate-5 deg/min as well as in Suscepter assisted sintering in 2.45 GHz Microwave Furnace at 600 ^{0}C for 30 min. at N_2 atmosphere (Heating rate-50 deg/min). Microstructural, densification and hardness studies were conducted. The properties and microstructures of the samples were summarized below. Significant amount of densification could not be observed possibly due to the presence of oxide layer on powder particles. Micro structural examination of microwave sintered sample revealed the presence of stronger interfacial bonding between particles as compared to the conventionally sintered one may be due to bulk heating in microwave sintering. Total process time reduces to 20% in Microwave sintering in comparison with Conventional sintering.

Condition	Green density	Sintered density	Hardness
Conventional	94.3% (500 MPa)	94.4% (500 MPa)	33±2 (500 MPa)
Microwave	92.7% (500 MPa)	92.9% (500 MPa)	35±2 (500 MPa)



(a) (b) (c) (d)

SEM micrographs of (a) As received Al powder (b) cryo-milled Al powder (c) Conventional sintered sample (d) Microwave sintered sample



Reduced sintering time in microwave sintering

Wear Behaviour of Cu-Al-TiC Composite

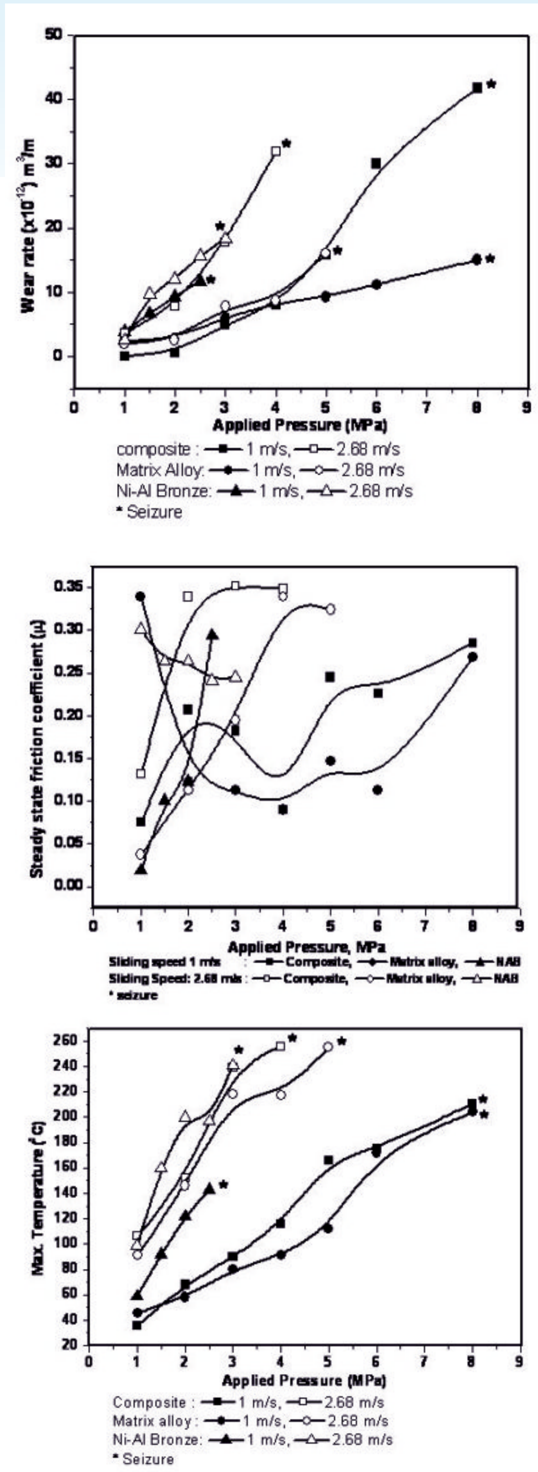
Cu-based composites offer attractive features like superior mechanical and tribological properties even at elevated temperatures when compared with the matrix alloy. They also have the potential for replacing bronzes in different applications. Wear studies on copper-based composites were carried out at AMPRI pertaining to their sliding wear behaviour in comparison to the bronzes.

Composite samples typically of 20 wt% TiC particles (<10 µm) dispersed in Cu-10Al alloy melt were prepared by stircasting method. Worn surfaces examined using SEM (JEOL JSM 5600). Dry sliding wear tests carried out using a pin-on-disk machine with sliding velocity: 1 m/s and 2.68 m/s and Sliding Distance: 500 m. The pressure was applied from 1 MPa to up to seizure.

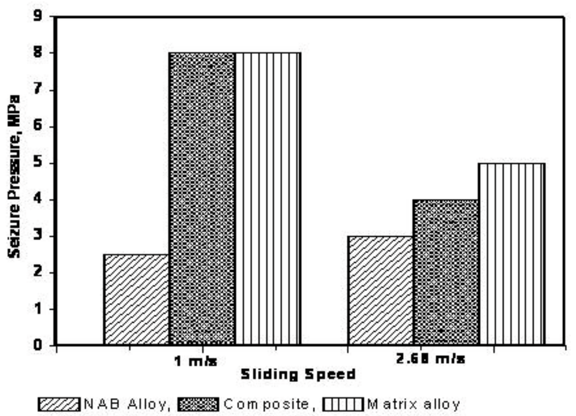
Material/ property	Composite	Matrix alloy	Ni-Al bronze
Hardness	206±4 HV	132±2 HV	156±2 HV
Density	7.19 g/cm^3	7.41 g/cm^3	7.56 g/cm^3
Composite : higher hardness and less density, NAB : higher density and intermediate hardness			

Wear rate increased with pressure and speed. The composite exhibited lower wear rate up to 3 MPa at 1 m/s. Intermediate wear response observed in composite. NAB showed higher wear rate at both the sliding speeds. In general slope of the plot for max. temperature rise vs applied pressure is sharper in all the materials. Maximum temperature rise attained by NAB up to (3 MPa) seizure pressure. Composite showed higher temperature rise at both speeds and all applied pressures in comparison with matrix alloy.

Composite showed higher steady state friction coefficient than matrix alloy at all applied pressures in both the speeds. NAB showed decreasing friction coefficient at 2.68 m/s and at 1 m/s increasing trend at increasing applied pressures.



Wear Behaviour of Cu-Al-TiC Composite



Sliding Speed and Seizure pressure of various composites

Lowest seizure pressure was attained by Ni-N bronze amongst all the materials at both speeds. Seizure pressure of composite and matrix alloy equals 1 m/s sliding speed. Composite exhibited lower seizure pressure at 2.68 m/s sliding speed in comparison with matrix alloy. In general as the applied pressure and sliding speed increased surface damage goses on increasing. Smoother wear surface observed in matrix alloy at both the speeds fallowed by composite and NAB. Seizure of the specimens at the speed of 2.68 led to more sever damage, stick slip pattern microcracks and fragmented dispersoid were observed. Extent of wear surface damage was higher in composite, fallowed by NAB and matrix alloy at 2.68 m/s sliding speed. Addition of TiC dispersoid to the matrix alloy caused a significant increase in hardness while density decreased.

Electro Magnetic Forming Technology of Metals and Alloys

Electro Magnetic forming (EMF) is a high velocity forming process which uses electromagnetic forces to form sheet-metal and joining or assembling similar/dissimilar metal components. A pulsed magnetic force produced due to interaction of two oppositely directed magnetic field, forms the work piece.

Typical parameters range of EMF process are given below :

- Voltage (peak) -------------- 2kV - 50kV
- Current (peak) --------------10 kA 100 k
- Mag. Field (peak) ---------- 10 - 50 T
- Frequency ------------------- 3KHz 150 KHz
- Pressure (peak) -------- hundreds of MPa
- Time of deformation ------ 10 100 µs
- Speed of Deformation ----- 50-300 m/sec
- Strain Rate ----------------- 1000-10000/s

AMPRI carried out extensive studies aimed at the development of the following automotive automotive components such as : 1. Crash box for Automobile, 2. Shock Absorber, 3. Wheel Disc.

Modified Johnson-Cook Model for Hot Deformation Processing

The need of a generalised flow curves considering strain (e), strain rate (_e) and temperature (T) is a primary requirement for material modelling related to several conventional and strategic mechanical processing to meet critical and non-critical engineering applications. The realistic coefficients of flow curves need to be obtained for such model. A modified Johnson–Cook (JC) material model has been proposed with physical significance. Six constants of this model can be obtained through the regression analysis. When compared to the JC model, proposed model is found to be more reliable for Al-2024 alloy. The convergence and accuracy of such model depends on the basic assumptions which are expected to satisfy certain requirements including the following:

1. They must maintain continuity that does not break at any realistic value of parameter.
2. They must cover the whole range of processing conditions.
3. Algorithm involve must be simple.

4. They should contain minimum number of arbitrary constants.
5. All the arbitrary constants must have some physical significance

$$\sigma = \left(AB + \varepsilon^{n}\right)\left(\frac{\dot{\varepsilon}}{\dot{\varepsilon}_0}\right)^{r}\left[1+\left\{\frac{\sigma_m}{\sigma_y}-1\right\}\exp\left\{-\alpha\left(\frac{T_m - T}{T - T_r}\right)^{\beta}\right\}\right]$$

Where, σ_y = Reference stress or Yield stress of the material,

ε_0 = Normalizing reference strain rate

T_m = Melting point of the alloy

T_r = Reference temperature

σ_m = True stress at the melting point

The proposed model has some other excellent properties that are as follows:

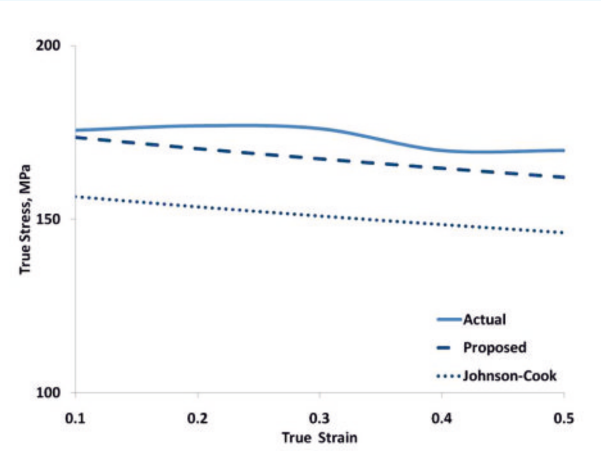
(1) Model has completely dimensionless terms.

(2) It allows any dimensions of the parameter - whether standard or non-standard. The only need of this model is that the unit should be homologous.

(3) This formula has only 6 numbers of constants to define a flow stress value which are very less in comparison to other similar formula [10] that contains in general 48 numbers of constant.

(5) This model is based on compression test whereas Johnson-Cook model needs compression and torsion tests both.

(6) Torsion test is more complicated than compression. So, proposed model is better as it does not need torsion test data. Here, the need of torsion test data has been eliminated by the addition of only one constant.



Comparison of flow curves at 100/s strain rate and 450^{0}C

There has been a strong push to produce high toughness in Al and Mg alloys through generation of ultra-refined grains. Al and Mg alloys may achieve high strength, but at the cost of ductility making them inadequate for major practical applications.

A number of methods have been attempted to improve the strength & ductility. While most of the earlier approaches improved ductility at the expense of yield strength, a few most recent approaches, Equal Chanel Angular Pressing (ECAP) has succeeded in simultaneously achieving high toughness.

In the light of above approach we proposed cryo-forming as an alternative to the above with more simplified processing to achieve the prominent properties of a structural material. The incorporation of high strength and good ductility would lead to many special applications of light weight metals, ideal for component development.

In order to achieve good strength and ductility, age hardenable Al & Mg alloys are competent where the strength may be enhanced by nano precipitation of second phase, where as the ductility can be retained with the generation of ultra-fine grains.

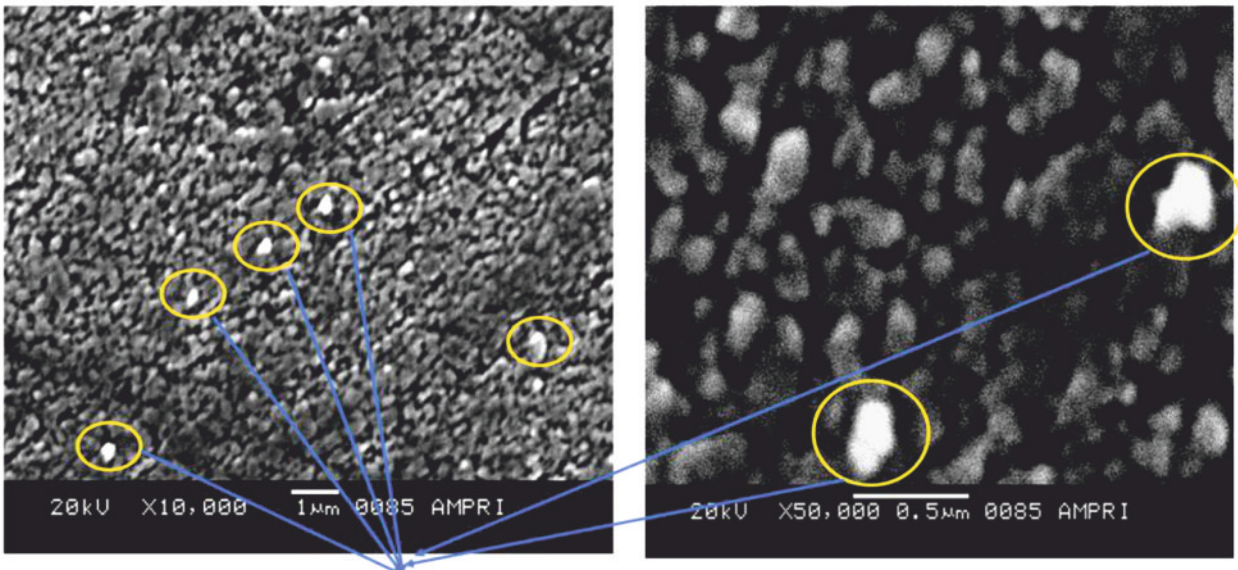
The processing steps for this approach include:

1. Solution-treating the Al/Mg alloy to dissolve a critical amount of second-phase and

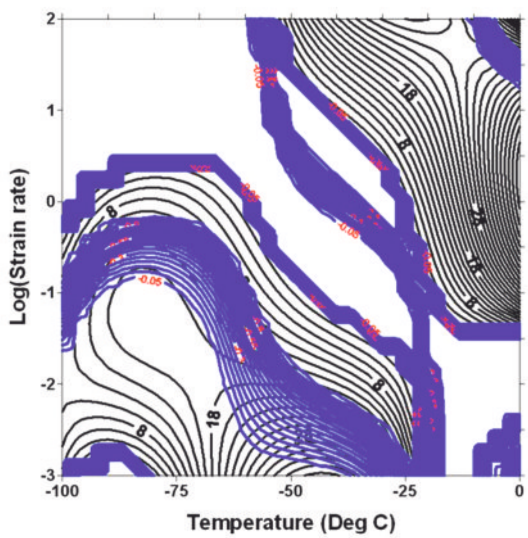
quenching it to produce an oversaturated solid solution.

2. Cryo-processing (both upsetting and rolling) at various set temperatures and strain rates to produce ultrafine-grained (UFG) micro-structures.
3. Aging the deformed material to produce highly dispersed nano second- phase for optimum hardness (strength).
4. Characterization for Microstructure evolution, hardness, yield strength at each stage.
5. Generation of Process Map & Microstructure Map for microstructure optimization.

Development of component with the use optimum mechanical properties and their field trial.



Nano size Al_2Cu precipitates



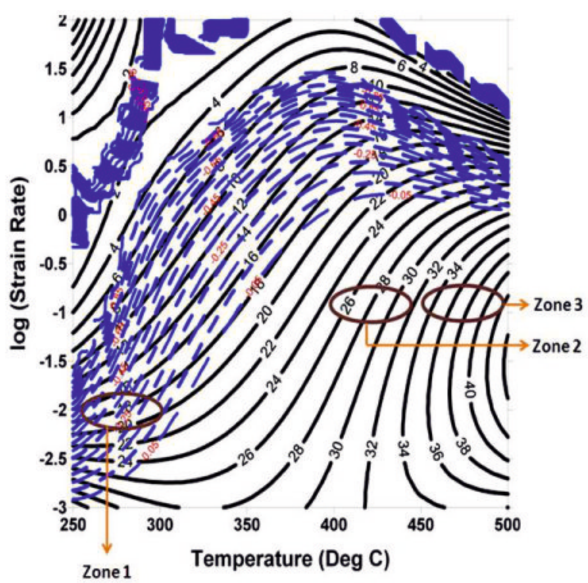
Process map of cryo formed Al-2024 at 0.4 true strain

4D Process Map

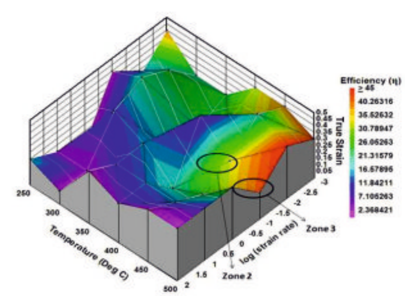
Previously only hit and trial method is the only mean to obtain the best processing condition and control the microstructure of the particular metal or alloy. But, as a result of lack in continuity of the observation of processing parameters, the hit and trial method may sometimes be unable to reach the best suitable condition. Thus, it is necessary to link the processing model to some material's visual continuum model that depicts the continuity in deformation parameters. Process map is the outcome of the continuum model which is based on FEM simulation that forms a link between different deformation stages and helps in optimizing the processing parameters from the point of view of hot workability and control of microstructure. It was suggested earlier that process maps at different strains do not show much difference and the strain components only define the frame of the microsystem. The visual process modeling is also important in showing the effect of stress and strain that particularly helps in designing the elevated temperature working processes, as well as for solving the problems encountered in every metal working practice

Process maps are generally a 2D visualization, which shows the efficiency as contours in strain rate and temperature space, they do not show the effect of strain in one visual representation. Advancements in software like Statistica, Sigmapro and D-plot, etc., allow the plotting of efficiency and instability values in 3D space of temperature, strain rate and strain, and thus provides a clear visualization and delineation of the deformability parameters as a function of these three processing variables. Such 4D visualizations are generally used in other scientific fields such as biotechnology, microbiology and forensic sciences, and is being used for the first time to study energy dissipation and instability during metal processing. Since 2D maps can correspond to one strain value only, a minimum of five processing maps (for the five strains) would be needed, but the reader will not be able to connect optimum deformability ranges between one map to the next. On the other hand, in the 4D map, the efficiency and instability values are shown as a continuum in the entire deformation space, and can be viewed in a contiguous fashion.

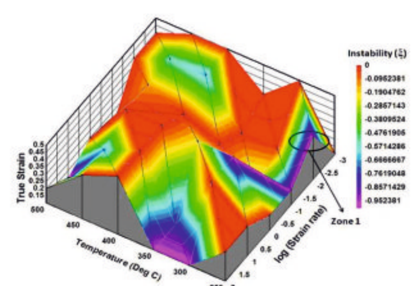
In view of the above we generated a new hybrid 4D process map that illustrates power dissipation η and instability with a variation in strain rate, temperature, and strain.



Process Map



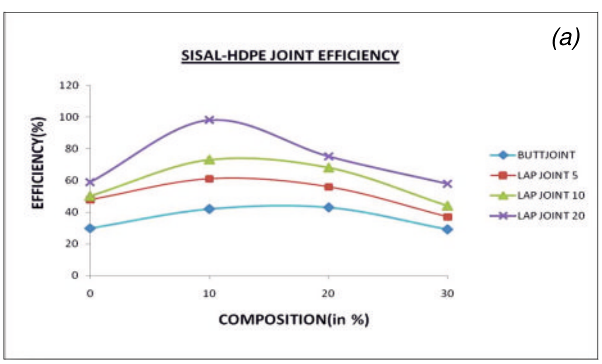
4D Power dissipation map

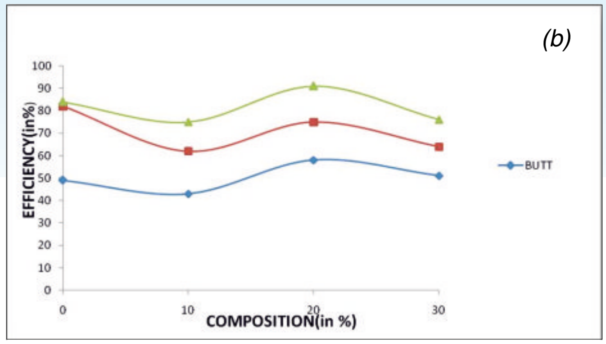


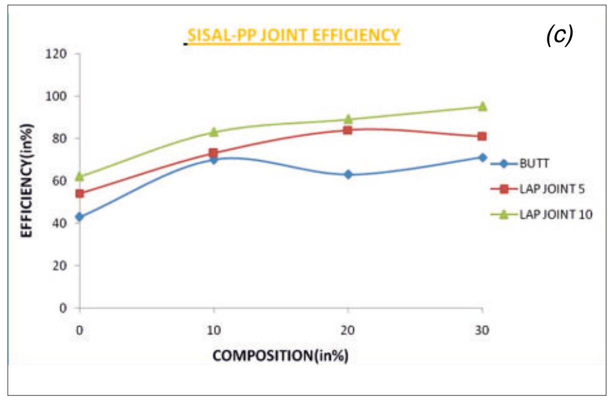
4D Instability map

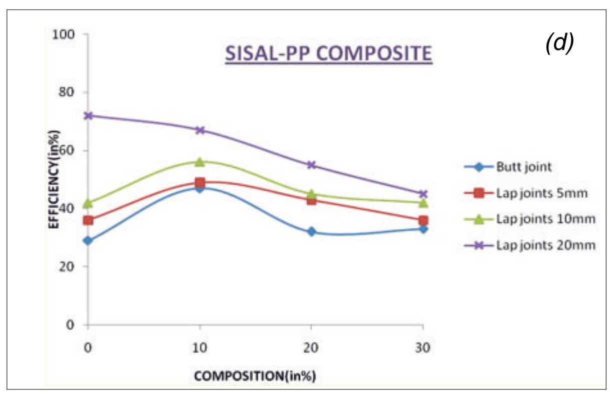
Evaluation of Efficiency of Hot Welding of Sisal Fiber Reinforced PP and HDPE Composites

The utilization of light weight, low cost natural fiber provides opportunities for substitutes in mineral, ceramic and synthetic fibers and fillers for many applications in automotive and aerospace sectors. Joining of composite material is an issue because traditional joining technologies are not directly transferable to composites. Until recently, joining of plastic did not receive much attention. Plastic parts most of them non-structural , could be molded in sufficient complexity to avoid the need for assembly. The joining of plastics and plastics composites are used for many applications. It is being used in complex structural assemblies where joining consideration and costs are becoming important. The emerging structural (load-bearing) applications of plastics require structural joints that must withstand static and fatigue loads. Joining products like automotive bumper is used in many demanding structural applications. In this work the joint efficiency of composite lap & butt joints which was welded after making composite sheet of Sisal-HDPE and Sisal PP was studied. The advantage of this new process are ease of joining, good joining strength, ease of carrying out mass production and low cost with time efficient. Natural fibers which contribute to biodegrability and easy availability were used. HDPE and Polypropylene were used for carrying out the study. Mechanical Properties are shown in the following figures :









***Sisal fibre-HDPE** Composite joint efficiency with respect to (a) Composite plain (b) Lap 21mm Sisal-PP composite joint efficiency with respect to (c) composite plain (d) Lap 20mm*

The joint efficiency of Sisal fiber PP and HDPE composites showed that lap joints are stronger than butt joints.

Wear Resistance Dependence on Compressive Strength of Rice Husk- PVC Foam Composites

Foamed polymer composites offer the benefits of the reduced material usage , weight and cost. Rice husk is an agricultural waste produced in bulk quantity during rice milling. Rice husk has been proved to be efficient agro filler for developing light weight polymer based composites. Rice husk filled and unfilled PVC foams can be candidate materials for light weight and partly bio degradable applications. In the present study, tribological characterization of rice husk filled PVC compound foam has been done.

Composites were made 10 (PRH10), 20 PRH20) and 30 % (PRH30) of untreated rice husk and treated rice husk (PTRH10, PTRH20, PTRH30) with foaming agent.

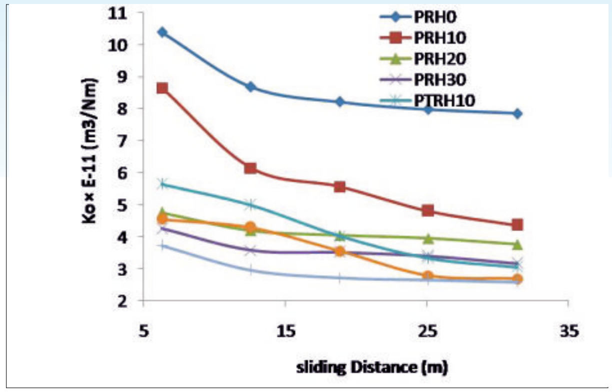
Abrasive wear measurements were done on three different grit size SiC abrasive papers, having average particle size 83 micron to evaluate the response of composites. The disc was rotated with a rotational speed of 200 rpm in a wear track diameter of 6 cm. 10 N load was applied for 10, 20, 30, 40 and 50 secs which corresponded to a sliding distance of 6.28, 12.56, 18.84, 25.12 and 31.40 m respectively. The weight loss was measured after each run after cleaning the sample using a soft brush. The specific wear rate (K_0) was calculated from the equation :

$$K_0 = \Delta W / \rho L D$$

where ΔW is the weight loss, ρ is density, L is the load and D is sliding distance.

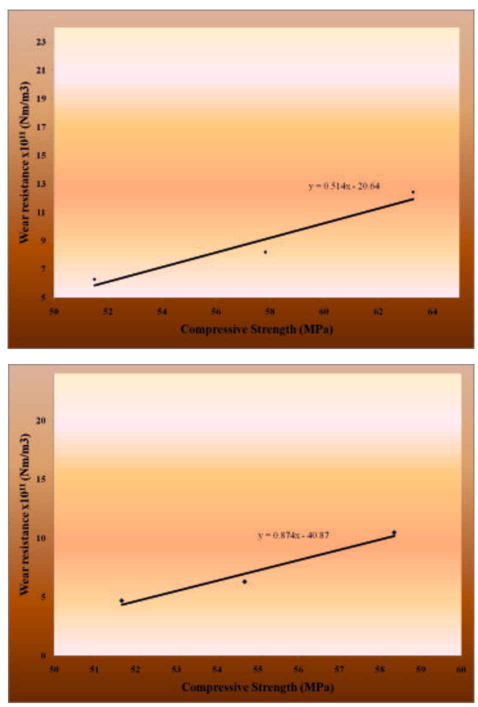
The observations indicated that with increasing abrading distance, the specific wear rate (K_0) decreased gradually. Obviously this is attributed to the multipass condition in which the severity of the abrasives decreased with repeated passes causing minimum wear for maximum test duration.

Wear resistance and compressive strength dependence is proposed for filled and unfilled

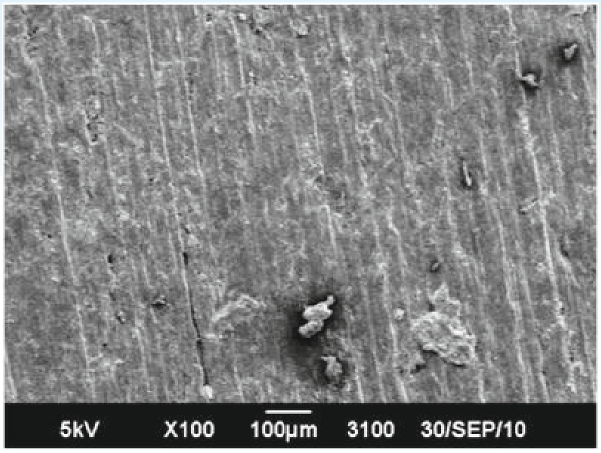


Abrading distance Vs Specific wear rate at 180 grade paper

PVC foam. Wear resistance (W_R) shows linear relation with compressive strength (C_s) of both untreated and treated rice husk PVC foam composites and follows the following relation $W_R = a\ C_s + b$ where a and b are constant. The values of a and b are 0.874, -40.87 and 0.514, -20.64 respectively for untreated and treated rice husk PVC foam composite.



Wear resistance (Nm/m^3) vs Compressive strength (MPa) of untreated and treated composites



Micro graph shows the deep wear grooves generated as a result of the repeated traversals of abrasive grit in the abrading direction.

Effect of Alkali treatment on Mechanical Properties of Sisal Fibre powder Poly Vinyl Alcohol (PVA) Film Composites

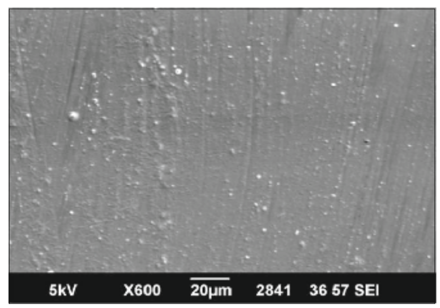
Polymers can be combined with organic natural fibres to produce total biodegradable composites. Cellular materials such as natural fibres, wood fibres and agro wastes, combined with polymers are known as Biodegradable composites. The main reason for combining sisal fibers with Biodegradable polymers is to create a new material. These composites can be superior to the neat PVA polymer in terms of material cost.

Composites were made having 0 %, 1% & 3 % sisal powder. The surface of sisal powder was modified by using NaOH for improving the coupling with the polymer. Some results are shown in the following table :

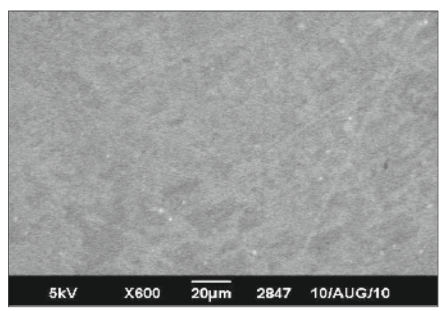
Films Sample name Tested at 10mm/min	Tensile strength MPa	Elongation % at Max
PVA	38.7	350.2
PVA+1wt% (untr.sisal Powder)	29.01	208.8
PVA+3wt% (untr.sisal Powder)	23.79	163.3
PVA+1wt% (5%NaOH tr. sisal Powder)	34.7	204.3
PVA+3wt% (5%NaOH tr. sisal Powder)	27.21	188.8

Tensile strength values of 0, 1 and 3 wt% untreated sisal fibre powder filled PVA films are found to be 38.3, 29.01 and 23.8 MPa respectively. Percentage elongation values of these composites are 350.2, 208.2 and 163.3 respectively. This shows that increase of sisal fibre powder loading decreased the tensile strength of composite film similar to other filled polymers. PVA composites were prepared with 70 hrs 5% NaOH treated sisal fibre powder. Tensile strength values of 1 and 3 wt%, 70 hrs 5% NaOH treated sisal fibre powder filled PVA films are 34.7 and 27.21 MPa .

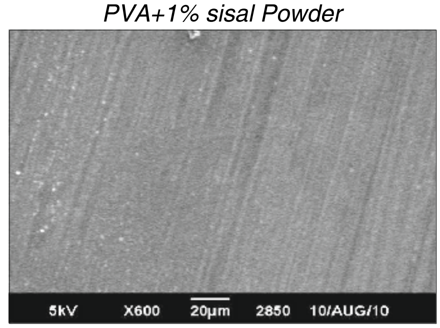
The following figures shows the microstructures of 0,1 and 3 wt % sisal powder PVA composites.



PVA



PVA+1% sisal Powder



PVA+3% sisal powder

Microstructures of sisal powder PVA composites

Abrasive wear behaviour of PP/ UHMWPE blend with and without hygrothermal treatment

Blending of polymers an important industrial technique, economical and versatile way in which new materials can be produced with a wide range of properties by merely using conventional processing equipment such as extruders or internal mixers. It is developed to substitute the pure polymer systems for a variety of applications. Find new applications in the areas of automobile, marine and aerospace industries. These applications demand lightweight, custom designed, cost effective materials. Polypropylene (PP) is an important commodity polymer, finding increasing use in industry.

Virgin Isotactic polypropylene (Koylene ADL grade-AS 030NS), of M/s IPCL, Vadodara, India, density 0.9 gm/cc and MFI 3.0 dgm/min was used in the study.

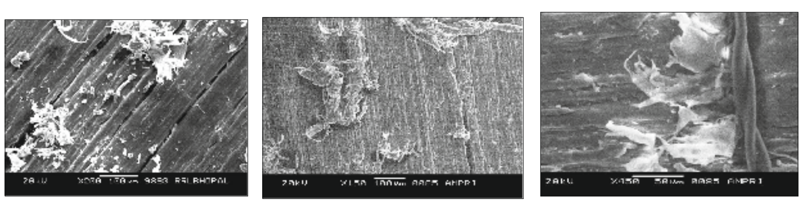
Ultra high molecular weight polyethylene (UHMWPE) a high abrasion resistant engineering polymer, having density 0.93 g/cc, MPFI 0.1 dgm/min was used. The average particle size was 75µm.

Abrasive wear testing was performed in multi pass mode. The wear rate of PP/UHMWPE (90/10) was determined and compared with PP.

Hygrothermal treatment of PP/UHMWPE based blend was carried out at 60°C temperature and 65 % RH (Relative Humidity) for different times. PP/UHMWPE (90/10) blend samples were prepared by using a mechanical extruder. Hygrothermal treatment was carried out for different time periods 200, 300, 400, 500 hours.

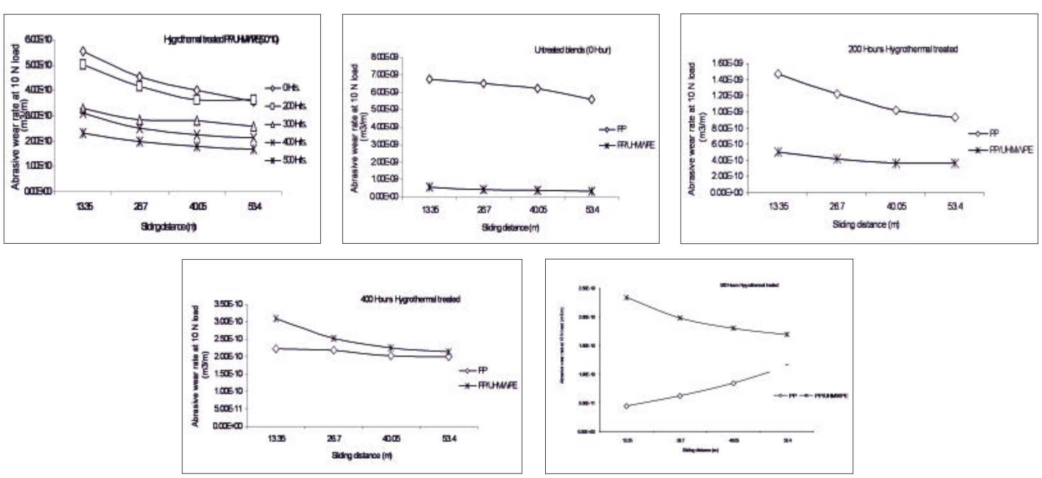
The worn microstructure clearly demonstrated that PP/UH (90/10) showed very less wear rate.

Hygrothermal treatment of PP and PP/UHMWPE blend reduced abrasive wear rate with longer treatment time. This reduction is more in PP where as reduction in PP/UHMWPE blend is comparably less. Wear rate decreases with increase in sliding distance of hygrothermal treated blend.



untreated *200 Hrs* *400 Hrs*

Microstructure of PP/UHMWPE blend



Hygrothermal treatment of PP and PP/UHMWPE Blend

CSIR-AMPRI

High Stress Wear Study of Sisal - Glass Fibre Hybrid Composites

Excellent mechanical and tribological properties of synthetic fibres proved them effective material for reinforcement in polymer resin but the environmental issues advocate the use of natural fibres as reinforcing material due to their biodegradability. The hybridization of natural fibre with synthetic fibres as reinforcement in composites may exhibit balanced mechanical properties. Hence a series of composites of epoxy resin reinforced with glass fibre (CSM), sisal paper and their combination were developed and studied for abrasive wear.

Epoxy resin was mixed with the hardener in a ratio of 10:8 at room temperature. Glass fibers in the form of Chopped Stranded Mat (CSM) having 350 GSM was used which has a density of 2.55 g/cm^3.

Different composites of Sisal-Glass- Epoxy were prepared by using sisal paper, glass CSM and epoxy resin in 5 different compositions.

Pin-on-disk wear tester was used for this abrasive wear study. Test samples were hold in vertical direction on a counter face having silicon carbide (SiC) abrasive paper of 400 grit size under multipass condition. Rectangular samples were used having10 mm width and 5 mm thickness. Abrasive wear performance of composites was evaluated at different loads to determine the response of composites in different pressure conditions. The composites were tested on three loads 10, 12.5 and 15 N. Five abrading distances were selected 6.28, 12.56, 25.12, 31.4 and 37.68 m for the study.

The incorporation of sisal fibre increased the wear resistance of composites under high stress abrasive wear. Composite having only sisal fibre exhibited lowest wear rate at all applied loads and composite having only glass fibre shows opposite behavior.

Effect of Temperature on the Mechanical Behaviour of Jute Fly-ash filled Polymer Composites

Natural fibers have many advantages over man-made fibers in that they are cheap, abundantly available and renewable, low-density, high specific properties as well as bio-degradable. In this research natural fibre composites have been developed using jute cloth as reinforcement in thermoset polymer matrix with fly ash studies have been done to access the mechanical properties of jute fly ash polymer composites at 20^{o} C temperature to check the composites properties for possible application under low temperature. Results indicate that polymer composite did not effect when exposed in low temp and have good potential in the future for use in low temperature region as a substitute for wood-based material in many applications.

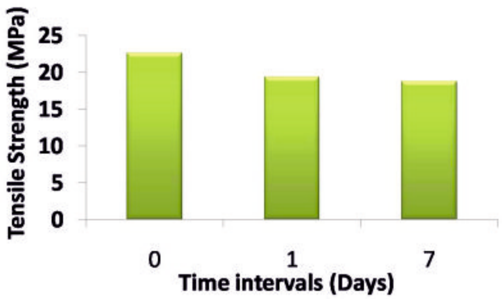
Composites of 5- 6 mm thick sample specimen were development under compression molding system. Tensile strength and Flexural strength of fly ash composites was tested as per ASTM D638 and ASTM 790 respectively. Impact strength of fly ash composites was performed as per ASTM D 256.

Tensile strength of fly ash jute polymer composite was 22.62 MPa (unexposed) and 19.35 MPa (expose at - 20^{o}C 1 day) and 18.72 MPa (expose at - 20^{o}C 7 days) , result showed that there is no effect of temperature in tensile strength.

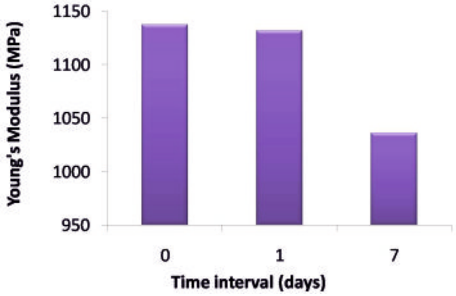
Young's Modulus of fly ash jute polymer composite was 1137.5 MPa (unexposed) and 1131.75 MPa (expose at - 20^{o}C 1 day) and 1036.25 MPa (expose at - 20 ^{o}C 7 days) result showed that there are not very much effected with low temperature exposure.

Flexural strength of fly ash jute polymer composite was 18.090 MPa (unexposed) and 17.038 MPa (expose at - 20^{o}C 1 day) and 17.35 MPa (expose at - 20^{o}C 7 days) , result showed that there is no effect of temperature in Flexural strength.

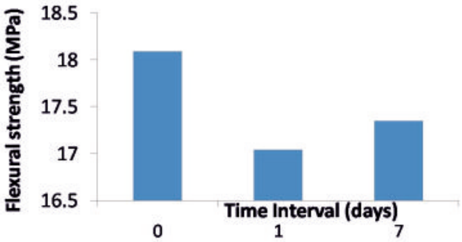
Impact strength of fly ash jute polymer composite was 2572.5 J/m^2 (unexposed) and 2870.0 J/m^2 (expose at - 20^oC 1 day) and 2750.0 J/m^2 (expose at - 20^oC 7 days) , result showed that there was no effect on Impact strength with temperature.



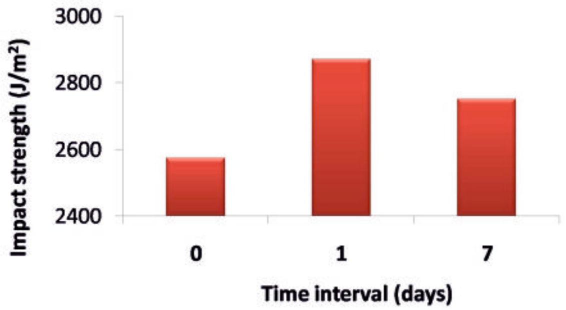
Tensile Strength of Fly Ash Composites



Young's Modulus of Fly Ash Composites



Flexural strength of Fly Ash Composites



Impact strength of Fly Ash Composites

Assessment of Comparative Characterization of Different Industrial Waste Particles

In the present study attempt were made to characterise (TGA/DTG, XRD, SEM and FT-IR) industrial wastes such as red mud, marble waste, jarosite waste and fly ash and to assess their potential for recycling and utilizing as raw materials for developing value added products. Results from the studies indicated that considerable quantity of waste produced from thermal power plants, aluminium industry, marble and mining industry can be recycled in developing building materials such as brick, light weight aggregates, roofing, flooring tiles, cements and in composites.

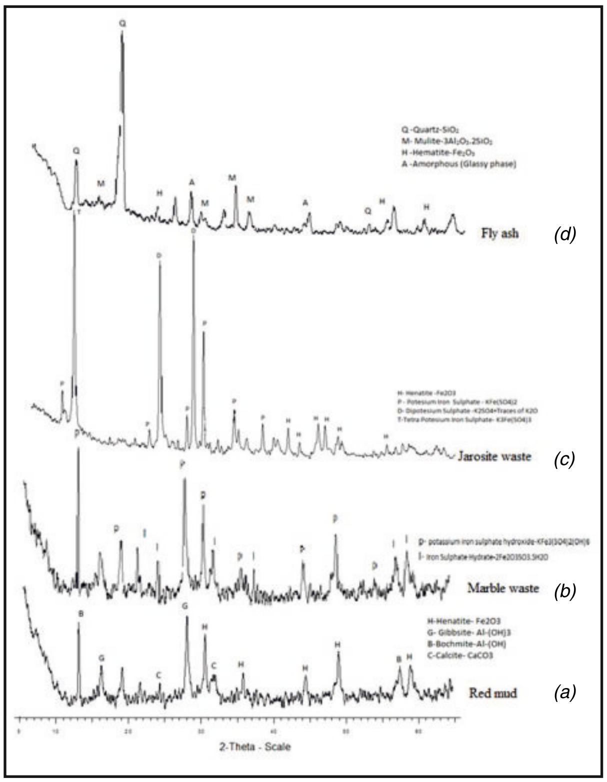
The red mud from Bharat Aluminium Co. Ltd. (BALCO) Korba, Chhattisgarh State, marble waste from marble processing industries, Jodhpur, Rajasthan, Jarosite waste from Hindustan Zinc limited (HZL), Debari, Rajasthan, and fly ash from Electro Static Precipitator of Satpura Thermal Power Station, Sarni were collected.

The XRD indicates that the mineral phase of jarosite waste is potassium iron sulphate hydroxide and iron sulphate hydrate, in fly ash dominant phases are quartz, mullite, and hematite. Marble dust shows quartz, kaolinite as the major phase. The mineral phases of red mud are hematite, boehmite, goethite, and calcite.

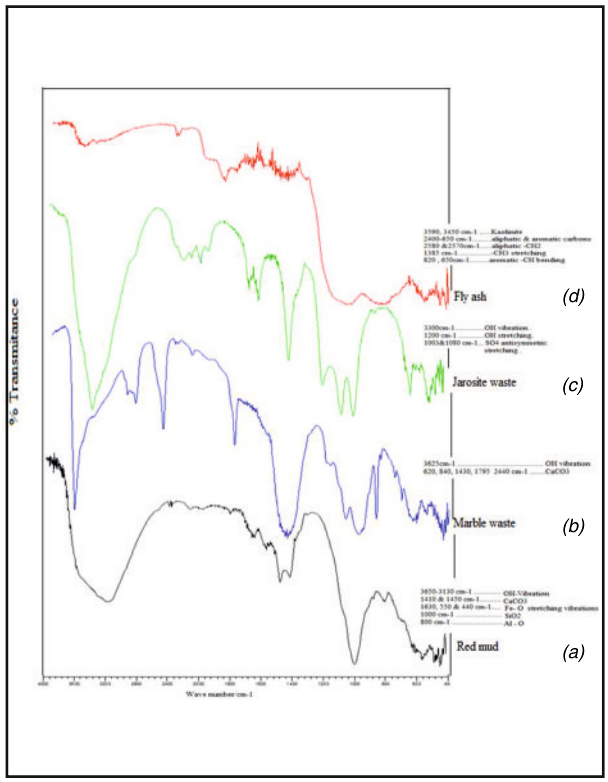
The FTIR spectrum of red mud shows the peaks at 1410 and 1450 cm^{-1} represent the existence of $CaCO_3$ and the peaks at 1000 cm^{-1} is for the SiO_2. Functional groups of marble waste were observed sharp peak around at 3625cm^{-1} region, which corresponds to OH vibration bond. The jarosite wastes are shown OH stretching region at the 3300 cm^{-1}. The spectrum of fly ash reveals that Kaolinite is present as one of the principal mineral matter at 3590, 3450 cm^{-1} band.

The SEM microstructure, it is evident that jarosite waste is irregular in shape with multiple humps. Fly ash is spherical and hollow shaped. The red mud powders are flake and spherical particles. The marble waste shows lumpy quartz particles and platy clay particles along with relatively bright lime bearing phase.

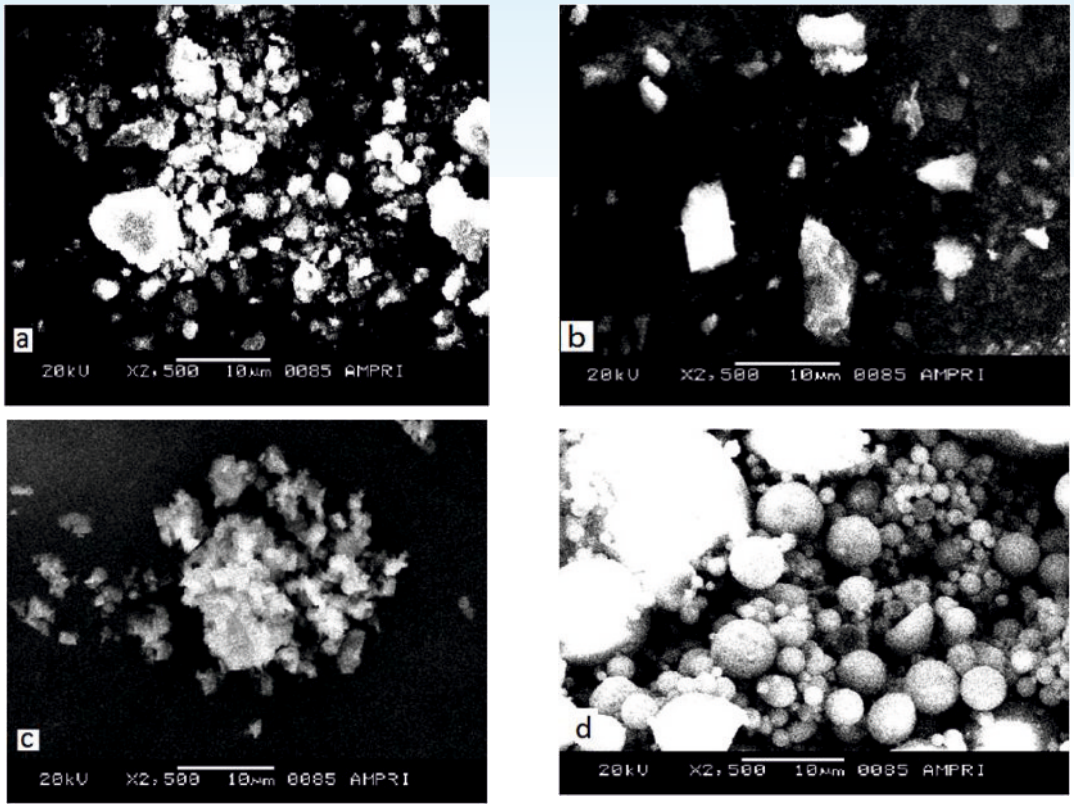
The thermal degradation of red mud is very sharp at the temperature of 250, 400, 500 and 650^{0}C. This indicates the decomposition of hydro hematite, Al-OH, Fe-OH and calcite. The decomposition of marble waste is shown an endothermic peak at 700^{o}C with 22.71% weight loss due to the $CaCO_3$ decomposed in CaO. Similarly the thermal analysis of jarosite has shown five mass loss steps at 125, 365, 564, 700 and 790^{0}C with 45% weight loss. Fly ash also decomposed in different mass steps of 300, 800, 950^{0}C.



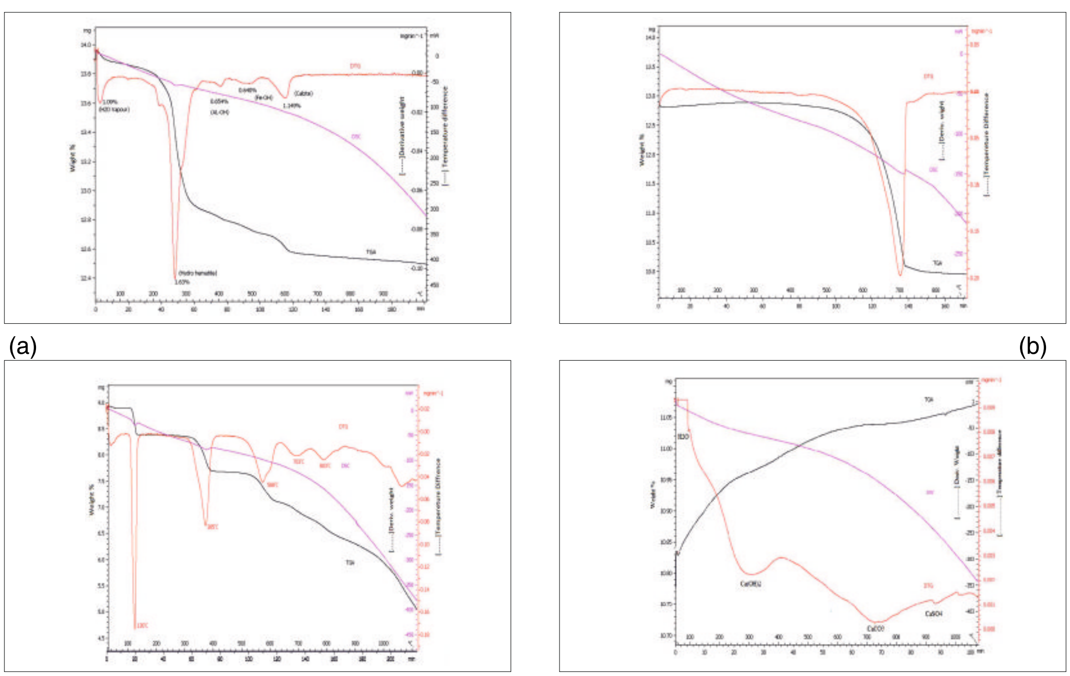
XRD of (a) Red mud (b) Marble waste (c) Jarosite waste and (d) Fly ash



FT-IR of (a) Red mud (b) Marble waste (c) Jarosite waste and (d) Fly ash



SEM images of (a) Red mud (b) Marble waste (c) Jarosite waste and (d) Fly ash



(c) *TGA/DTG/DSC of (a) Red mud (b) Marble waste (c) Jarosite waste and (d) Fly ash* (d)

General INFORMATION

Research Council

April 1, 2007 - March 31, 2010

Dr. G. Sundararajan Director International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI) Balapur P.O. Hyderabad – 500 005 A.P.	Chairman (April 2009 onwards)
Dr. Anil K Gupta K L Chair Prof. of Entrepreneurship Indian Institute of Management Vastrapur, Ahmedabad – 3800151	Member
Shri R.K Celly Former Executive Director Building Materials and Technology Promotion Council (BMTPC) India Habitat Centre, Lodi Road , New Delhi – 110 003	Member
Dr. Vikram Jayaram Professor Department of Materials Engineering Indian Institute of Science Bangalore – 560 012	Member
Dr. Arun Jaura Vice President – Technology Eaton India Engineering Center 145, Off Pune Mumbai Road, Pimpri Pune, Maharashtra - 411 018	Member
Dr. P. K. Verma Director General M.P. Council of Science Technology Vigyan Bhawan, Science Hills MANIT Campus, Nehru Nagar Bhopal – 462 003	Member (October 2008 onwards)

Prof. B.B. Dhar Ex-Director, (CMRI, Dhanbad) D-20, Pamposh Enclave New Delhi - 110048	Member
Shri S. Khuntia Scientist G & Head Design & Rural Technology Department Institute of Mineral and Materials Technology Bhubaneswar -751013	Member (DG's Nominee)
Dr. P.G Rao Director North-East Institute of Science and Technology P.O. Jorhat, Jorhat -785006	Member (Sister Lab Representative)
Dr. Anil K.Gupta Director Advanced Materials and Processes Research Institute (AMPRI) Near Habibganj Naka Bhopal – 462 064	Member (April 2009 onwards)
Dr. Naresh Kumar Head R&D Planning Division CSIR, Rafi Marg. New Delhi -110001	Member (Permanent Invitee)
Dr. Navin Chandra Scientist 'G' AMPRI, Bhopal – 462 064	Member Secretary

Management Council

July 2007-December 2009

Dr. Anil Kumar Gupta, Director, CSIR-AMPRI	Chairman (April 2009 onwards)
Dr. C.B Raju, Scientist G	Member
Dr. (Ms.) Mohini Saxena, Scientist F	Member
Dr.O.P Modi, Scientist F	Member
Mr. Sanjay Panthi, Scientist	Member
Mr. A.A Baksh, AEE	Member
Head, PME / RDPD	Member
F&AO/CoFA	Member
Mr. S.K.Gupta, CoA	Member Secretary

January 2010 - December 2011

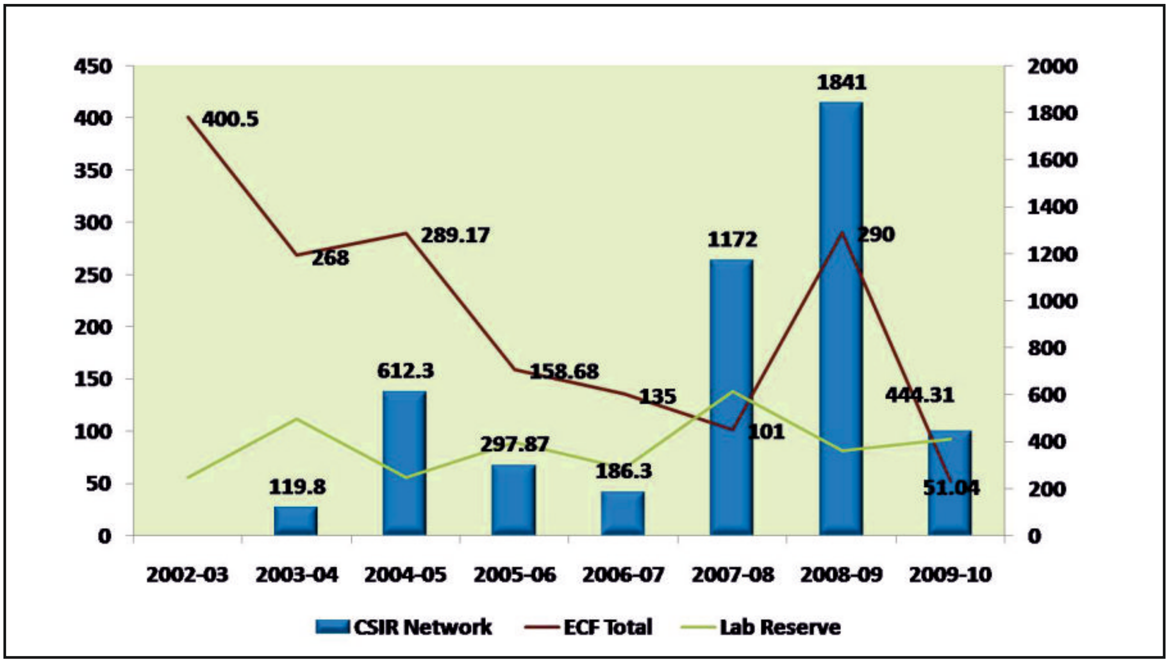
Dr. Anil K. Gupta, Director, AMPRI	Chairman
Dr. S. Gangopadhyay, Director, CRRI, New Delhi	Member
Dr. Navin Chandra, Scientist G	Member
Mr. P. D. Ekbote, Scientist G & Head, PME	Member
Dr.S. Das, Scientist G	Member
Dr. P. Asokan, Scientist E-II	Member
Dr. (Ms.) Deepti Misra, Scientist E-I	Member
Dr. (Mrs.) Prabha Padmakaran, Sr. Tech. Officer	Member
CoFA / F&AO	Member
Sr.CoA/CoA/AO	Member Secretary

Budget

(Rs. Lakh)

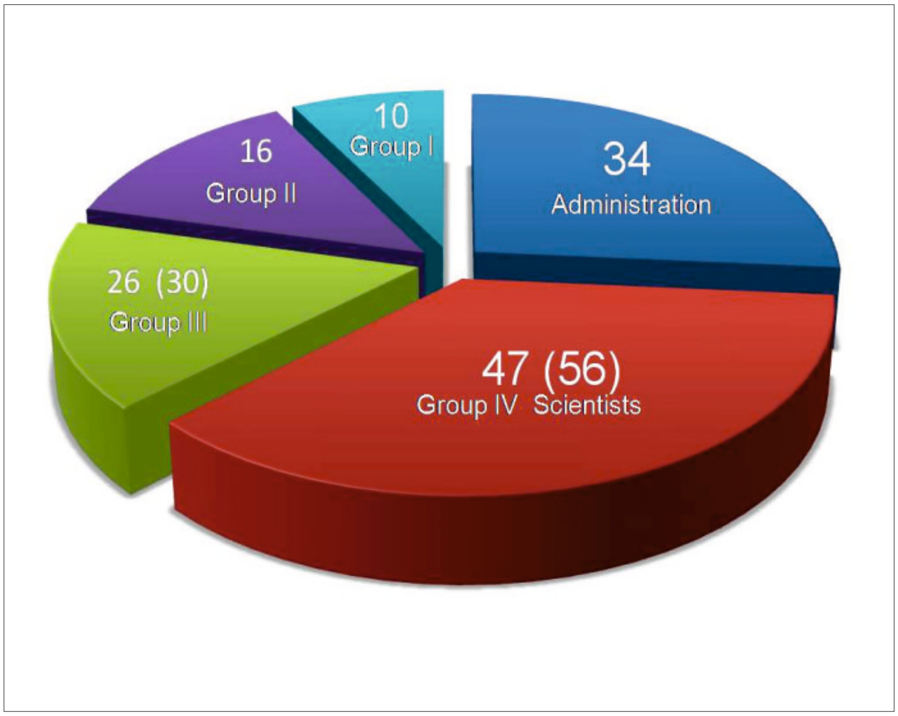
Year	ECF Total	CSIR Network	Lab Reserve
2002-03	400.50	-	55.00
2003-04	268.00	119.80	111.00
2004-05	289.17	612.30	55.00
2005-06	158.68	297.87	88.85
2006-07	135.00	186.30	63.80
2007-08	101.00	1172.00	137.70
2008-09	290.00	1841.00	81.00
2009-10	**51.04**	**441.31**	**92.00**

Rs. Lakhs



Human Resources

Staff Position (Year Ending March 2010)	Numbers
Group IV	47
Group III	26
Group II & I	26
Administration	34
Floating Staff	56
JRFs/SRFs/RAs/Project Assistants	



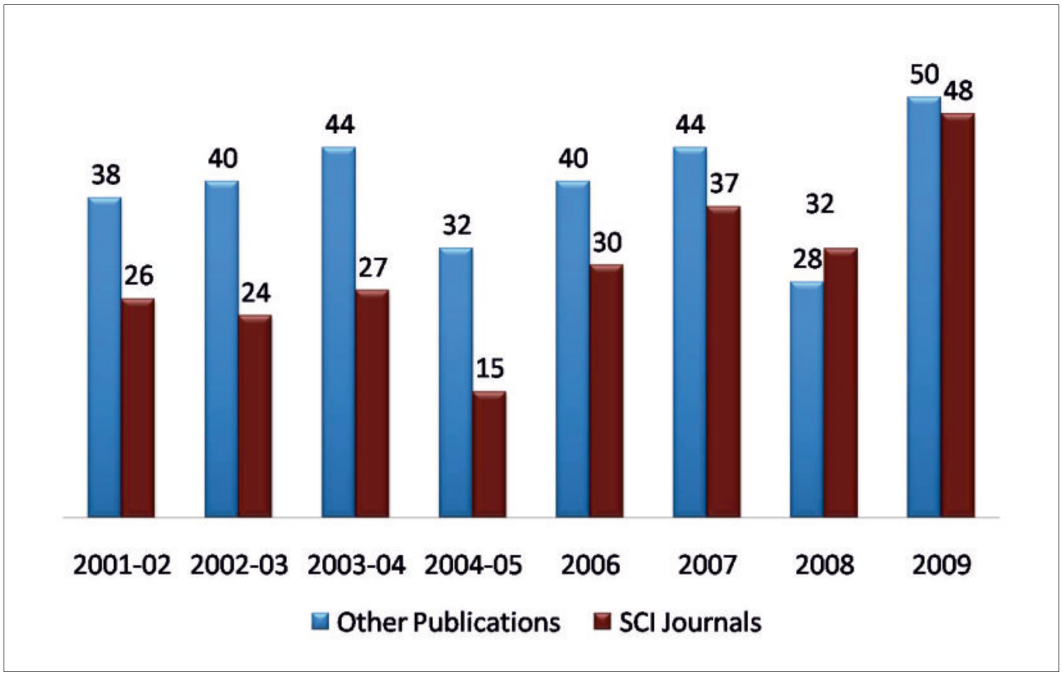
Total Staff : 133

(Figures in bracket are the sanctioned strength)

Floating Staff (Research Scholars, PA`s etc. : 56)

Research Publications

Year	Other Publications	SCI Journals
2001-02	38	26
2002-03	40	24
2003-04	44	27
2004-05	32	15
2006	40	30
2007	44	37
2008	28	32
2009	50	48



Foreign Patents in Force

S.No.	Title of the patent	Date of Grant	Patent No.	Country.
1.	A process for the manufacture of aluminum graphite particulate composites using unquoted graphite particle for automobile & engineering application.	14/03/1990	2194799	UK
2.	A process for the manufacture of aluminum graphite particulate composites using unquoted graphite particle for automobile & engineering application.	07/08/1990	4946647	USA
3.	A process for the manufacture of aluminum graphite particulate composites using unquoted graphite particle for automobile & engineering application.	19/09/1990	610516	AUS
4.	A Low temperature process for making alkali free high surface area, amorphous, silicon precursor and its application making advanced ceramic materials such as silicon carbide, mullite.	08/03/2007	19952337	Germany
5.	Low temperature process for making radiopac materials utilizing industrial/agricultural waste as raw material	28/4/2009	7524452	USA

Indian Patents in Force

S.No.	Title of the patent	Date of Grant	Patent
1.	A process for the extraction of potash useful for fertiliser application from feildspar	29.12.2000	184097
2.	An improved process for the preparation of alumina silicon carbide composites	28.03.2003	188036
3.	A process for production and application of glazing material produced from foundry slag	15.03.2004	190600
4.	An improved process for the preparation of beta-silicon carbide whiskers useful for making metal/ceramic/glass matrix composites	30.11.2004	191807
5.	A process for recovery of zinc by oxidizing roasting of zinc ash	13.01.2006	193952
6.	A non toxic composition useful for cleaning/descaling of apertures/pipes and process for cleaning/de scaling of Apertures/pipes	20.01.2006	193953
7.	A composition of red mud - thermopalstic composites useful for environment friendly domestic and industrial application.	10.02.2006	194596
8.	An improved process for making value added products such as ceramic tiles	07.04.2006	194600
9.	An Improved process for the preparation of metal matrix c omposites	23.06.2006	196946
10.	A process for melts blending of incompatible non-interactive polymers in homogeneous mixture	07.07.2006	195804
11.	A Process for preparation of tiles and slabs from waste slag of foundry cupola	12.01.2007	202357

Ongoing Projects

Grant-in-Aid

S.No.	Details of the Project	Cost Rs. Lakhs
1	GAP 0053-BRNS-03 Wear performance evaluation of Ni-Ti based Shape Memory Alloys and composite under sliding and cavitation erosion conditions	23.620
2	GAP 0057-BRNS-08 Development of lead free, multicomponent composite materials using conventional and advance ceramic route for simultaneously and synergistically shielding of gamma and neutron radiation	23.100
3	GAP 0058-TIFAC-08 Demonstration of the competence to develop automobile components using Electro Magnetic Forming (EMF) process	270.600
4	GAP 0059-MAPCOST Ancient technology of Wootz steel making process upgradation, revival, dissemination and provision of safety net	15.440
5	GAP 0060-BRNS-09 Feasibility studies on development of pulsed electromagnetic welding technique for refractory materials used in high temperature reactors	15.237
6	GAP 0061-MAPCOST-09 Development of Noise Absorbing Materials (Noise Barriers) from industrial rubber waster for use in engineering applications	6.63
7	GAP 0062-MAPCOST-09 Utilization of low cost minerals of Madhya Pradesh for the development of hyperbranched aluminosilica (HAS) and mesoporus to silica to sequester the effects	15.6
8	GAP 006-MOS-09 Alternate Complimentary route of direct steel making with reference to Indian raw materials	62.4

Sponsored

S.No.	Details of the Project	Cost Rs. Lakhs
1	SSP 0030-CT-05 Modifications of PPG/PEF floor Lining	6.612
2	SSP 0032-GMDC-06 Rapid Environmental Impact Assessment for Beneficiation of Plant modernization and fluorspar mining at Ambadunagar	10.000
3	SSP 0034-BHEL-07 Alternative environment friendly material as replacement for the asbestos cloth	9.900
4	SSP 0035-BHEL-07 Alternative environment friendly material as replacement for the asbestos putty	9.900
5	SSP 0036-BRNS-10 Testing of grooved tensile specimens of a nuclear reactor material under subzero temperature to determine failure probabilities in ductile to brittle transition temperature range	17.528
6	SSP 0037-BHEL-10 Comparison of processing route and the material for producing cost effective spider key bar profile with improved property	22.000

Consultancy

1	CNP 0097-TIFAC-06 Field demonstration cum training programme for use of fly ash in agriculture in farmer's field at Sarni Thermal Power Station of MPSEB	15.000
2	CNP 0099-GMDC-06 Rapid Environmental Impact Assessment and environmental management plan for Lignite Mine at Umarsar, Dist Kutch.	5.000

CSIR EFYP - NWP

S.No.	Details of the Project	CostRs. Lakhs
1	NWP 0028 Development of Advanced Light Weight Metallic Materials for Engineering Applications. AMPRI-NIIST-NML-NPL	2950.000
2	NWP 0029 Non-oxide Ceramic based Advanced Structural materials for Application in Armours CGCRI-AMPRI-SERC	150.000
3	NWP 0035 Nanomaterial and Nanodevices for application in Health and Diseases CCMB-CEERI-AMPRI-CECRI	182.000
4	NWP 0037 Discovery and Preclinical Studies of New Bioactive Molecules (Natural and Semi-Synthetic) & Traditional Preparations IIIM-CIMAP-CDRI-NBRI-IICB-IICT-AMPRI-NCL-NEIST-IHBT	15.500
5	NWP 0046 Sustainable Development and Management of Water Resources in Different Problematic Terrain NGRI-AMPRI-NEERI	61.770
6	NWP 0051 Nanostructured Advance Materials NML-AMPRI-CEERI-CGCRI-CMERI-IMMT-NAL-NCL-NPL	257.000

CSIR EFYP RSWNET RSP

7	RSP 0001 Sisal- Potential for Rural Development & Green Technology	450.000
8	RSP 0002 Dissemination and Showcasing of Rural Technologies	50.000

List of Completed Projects

S. No.	Type of the project	Project Title	Sponsoring Agency	Project Cost (Rs. Lakh)
1	SSP-0022-RSMML-04	Risk assessment and safety audit for industrial beneficiation plant (phosphate division) of RSMML, Udipur	RSMML	3.00
2	SSP-0029-NMRL-05	Development of cast in – situ copper based metallic matrix composites for naval application and Simulation of their micro structuralv features vis-à-vis properties through FEM analysis	NMRL	9.90
3	CNP-0086-BHEL-05	To advice on suitable FRP material and to Develop prototype V block for hydro Generator	BHEL	06.90
4	(CNP-0094-RIL-05)	Rapid environmental impact and risk assessment for hydrocarbon terminal at Abu road, Rajasthan	RIL	09.00
5	(CNP-0102-UNICEF-06)	Rapid assessment of drinking water quality in the State of Madhya Pradesh	UNICEF	16.06
6	(GAP-0031-DST-03)	Establishment of permanent GPS station	DST	10.35
7	(GAP-0045-BRNS-05)	Development of a noval and energy efficient process for Making Lead and rare earth free ceramic shielding material using industrial waste	BRNS	11.855
8	(GAP-0049-BRNS-05)	Micro meso and macroscopic analysis of ductile fracture using FEM	BRNS	35.28
9	(COR-0005-CSIR-02).	Development of Techniques and methodologies for exploration, assessment and management of groundwater in hard rock areas	CSIR	103.68
10	(COR-0008-CSIR-04)	Industrial Waste Minimization	CSIR	101.00

Sl. No.	Type of the project	Project Title	Sponsoring Agency	Project Cost (Rs. Lakh)
11	(COR-0009-CSIR-04)	Quality Enhancement of Coal for its effective Utilization	CSIR	97.00
12	(COR-0012-CSIR-04)	Design Analysis and Health Assessment of Special Structures including bridges	CSIR	50.00
13	(COR-0021-CSIR-04)	Developing Capabilities in Advanced Manufacturing Technologies	CSIR	13.8
14	(COR-0022-CSIR-04)	Technology for Engineering Critical Assessment	CSIR	134.50
15	(CMM-0011-CSIR-03)	Developing Capabilities and Facilities for MEMS and Sensors	CSIR	173.83
16	(CMM-0019-CSIR-02)	Developing New Building Construction Materials and Technologies	CSIR	140.60
17	(CMM-0020-CSIR-04)	Mathematical Modeling and Computer Simulation	CSIR	216.00
18	(CMM-0022-CSIR-03)	Custom Tailored Special Materials	CSIR	82.27
19	(CMM-0023-CSIR-03)	Capacity Building for Coastal Mineral Mining	CSIR	37.90
20	(SMM-0005-CSIR-04)	Fugitive Emission Monitoring and Development of Emission Factors for Petroleum Storage	CSIR	56.00

Research Publications - 2009

Anshul A, Amritphale S S, Chandra N, Ramakrishnan N, Shrivastav A, Verma U S P

Chemically formulated ceramic gamma ray irradiation shielding materials utilising red mud
Advances in Applied Ceramics,
108, 7, 429-437, 2009

Ansarifar A, Wang L, Osmani M, Asokan P

Assessing the Effect of thermoset polyester resin waste powder on the processing and mechanical properties of natural rubber
Journal of Rubber Research,
12, 1, 2009, 12-26

Chand Navin and Nigrawal A

Development, dielectric and thermal studies on HAF carbon filled polyester gradient Composites
Journal of Composite Materials,
43, 24, 2009, 2859-2869

Chand Navin, S A R Hashmi, U K Dwivedi

Concentration Profile of Glass Fiber Bundles in Epoxy- Based Gradient Composites During Centrifugation
Journal of Applied Polymer Science,
113, 2009, 3840–3846

Chandra Navin, Meenakshi Sharma, Deepesh Kumar Singh and S S Amritphale

Synthesis of nano-TiC power using titanium gel precursor and carbon particles
Materials Letters, 63, 12, 2009, 1051-1053

Asokan P, Osmani M, Price A D F

Assessing the recycling potential of glass fibre reinforced plastic waste in concrete and cement composites
Journal of Cleaner Production, 17, 2009, 821–829

Chand N, Das Jhod B, Kumar V

Development, Mechanical, Thermal and Electrical Properties of Linseed Husk Powder Filled PVC Composites
Journal of Biobased Materials and Bioenergy, 3, 2, 165-171, 2009

Chand Navin, S K Bajpai and Grace Mary

Coper (II) and copper nanoparticles-loaded chemically modified cotton cellulose fibres with fair antibacterial properties
Journal of Applied Polymer Science,
113, 2009, 757-766

Chand Navin, Das Jhod B

Mechanical, electrical and Thermal Properties of Maleic Anhydride Modified Rice Husk Filled PVC Composites
Bio Resources
3 (4), 2009, 1228-1242

Dwivedi U K, Navin Chand

Influence of Fibre Orientation on Friction and Sliding Wear Behaviour of Jute Fibre Reinforced Polyester Composite
Appl. Compos Mater., 16, 2009, 93–100

Dwivedi U K, Navin Chand

Influence of MAg PP on abrasive wear behaviour of Chopped sisal fibre reinforced PP Composites
Journal of Materials Processing Technology
209, 2009, 5371

Dwivedi U K, Ajoy Ghosh, Navin Chand

Role of PVA Modification in Improving the sliding wear behaviour of Bamboo
Bio Resources, 4, 2, 2009, 522-528

Grace M, Chand N, Bajpai, S K

Copper Alginate-Cotton Cellulose (CACC) Fibers with Excellent Antibacterial Properties
Journal of Engineered Fibers and Fabrics
4, 3, 2009, 24-35

Gupta Nitish, S S Amritphale, Navin Chandra

Removal of lead from aqueous solution by hybrid precursor prepared by rice hull
Journal of Hazardous Materials
163, 2-3, 30, 2009, 1194-1198

Gupta Neelmani, Murari Prasad, N Singhal, Vineet Kumar

Modelling the adsorption kinetics of divalent metal ions onto pyrophyllite using the integral method Ind. Eng. Chem. Res., 48, 4, 2009, 2125-2128

Hashmi S A R and Dwivedi, U K

SiC Dispersed Polysulphide Epoxy Resin Based Functionally Graded Material
Polymer Composites, 30, 2, 2009, 162-168

Hashmi S A R, Dwivedi U K, Chand N

Concentration Profile of Glass Fiber Bundles in Epoxy-Based Gradient Composites During Centrifugation Journal of Applied Polymer Science 113, 6, 2009, 3840-3846

Majumder A K

A Device for Measuring Thin Fluid Flow Depth Over an Inclined Open Rectangular Channel
Journal of Fluids Engineering-Transactions of The ASME, 131, 10, 2009

Majumder A K, Shah H, Choubey S, Barnwal J P, Kundu A K, Dhillon P S

Applicability of a Dense-Medium Cyclone and Vorsyl Separator for Upgrading Non-Coking Coal Fines for Use as a Blast Furnace Injection Fuel,
International Journal of Coal Preparation and Utilization, 29, 1, 2009, 23-33

Mondal D P, Das S, Jha Nidhi

Dry Sliding wear behavior of Aluminium syntactic foam
Materials & Design
30, 7, 2009, 2563-2568

Mondal D P, Goel M D, Das S

Compressive deformation and energy absorption characteristics of closed cell aluminum-fly ash particle composite foam
Materials Science and Engineering: A,
507, 1-2, 2009, 102-109

Mondal D P, Das S, Badkul A, Jha N

Modelling of Evaporative Cooling of Porous Medium Filled with Evaporative Liquid
CMC-Computers Materials & Continua
13, 2, 2009, 115-134

Mondal D P, S Das, N Ramakrishnan, K Uday Bhaskar

Cenosphere filled aluminum syntactic foam made through stir-casting technique
Composites Part A: Applied Science and Manufacturing, 40, 3, 2009, 279-288

Mishra D, Khan MA, Mudgal M, Padmakaran P, Chakradhar B

Performance evaluation of an effluent treatment plant for a pulp & paper mill
Indian Journal of Chemical Technology
16, 1, 2009, 79-83

Mondal D P, Goel M D, Das S

Effect of strain rate and relative density on compressive deformation behaviour of closed cell aluminum-fly ash composite foam
Materials & Design, 30, 4, 2009, 1268-1274

Panthi S K, Ramakrishnan N, Ahmed M, Singh S S, Goel M D

Finite Element Analysis of sheet metal bending process to redict the spring back
Materials & Design 31, (2), 2009, 657-662

Padmakaran P, Chakradhar B

Assessment of ground water quality of Bhavnagar Region, Gujarat
Journal of Scientific & Industrial Research
68, 11, 2009, 964-966

Prasad B K and Modi O P

Slurry Wear Characteristics of Zinc-Based Alloys: Effects of Sand Content of Slurry, Silicon Addition to Alloy System and Traversal Distance
Transactions of Nonferrous Society of China 19, 2009, 277-286

Prasad B K

Influence of Suspended Talc Particles in Oil and Nature of Material Microconstituents on Sliding Wear Characteristics of Cast Iron and Zinc-Based Alloy, Canadian Metallurgical Quarterly, 48, 2009, 455-464

Pathak K K, Rajeev Arya, Neeraj Jain, Alok Chaube

Preform map for mild steel upsetting and its experimental verification
J. Brazilian Society Mechanical Engg.,
31, 3, 2009

Prasad B K

Sliding Wear Behaviour of a Cast Iron as Affected by Test Environment and Applied Load
Industrial Lubrication and Tribology,
61, 2009, 161-172

Pathak K K, Lomash S, Jha A K, Ramakrishnan N

Process and Die Profile Design for Tube Extrusion of g Iron
Structural & Multidisciplinary Optimization, 40, 1, 2009, 491-496

Pathak K K, Lomash S, Neeraj Jain, Jha A K

Tube extrusion design for some selected inner profiles
Int. J. Physical Sc. 4, 2, 2009, 69-75

Ruhi G, Modi O P, Singh I B

Pitting of AISI 304 SS coated with nano structured sol-gel alumina coating in chloride containing acidic environment
Corrosion Science, 51, 2009, 3057-3063

Ruhi G , Modi O P, Singh I B

Corrosion behaviour of nano structured sol-gel alumina coated 9Cr-1Mo ferritic steel in chloride bearing environment
Surf. Coat. Tech., 204, 2009, 359-365

Ruhi G, Modi O P, Singh I B

Effect of sintering atmosphere on the corrosion and wear resistance of sol-gel alumina coated mild steel surface
Corrosion, 65, 2009, 758-764

Ruhi G, Modi O P, Jha A K, Singh I B

Characterization of corrosion resistance properties of sol gel alumina coating in mine water environment
Indian J. Chem. Tech. 16, 2009, 216-220

Rathod S, Modi O P, Prasad B K, A Chrysanthou, D Vallauri, V P Deshmukh A K Shah

Cast In-Situ Cu-TiC Composites: Synthesis by SHS Route and Characterization
Materials Science and Engineering A,
502A, 2009, 91-98

Rao R N, Das S, Mondal D P, Dixit G

Dry sliding wear behaviour of cast high strength aluminium alloy (Al–Zn–Mg)
and hard particle composites
Wear 267,
9-10, 2009, 1688-1695

Saxena S, Ramakrishnan N

An improved method for numerical determination of SZW using FEM
Nuclear Engineering and Design
239, 7, 2009, 1207-1211

Sikand Rajiv, Arun M Kumar, Anil K Sachdev, Alan A Luo, Vipin Jain and Anil K Gupta

AM30 porthole die extrusions—A comparison with circular seamless extruded tubes
Journal of Materials Processing Technology, 209, 18-19, 2009, 6010-6020

Saxena S, Ramakrishnan N, Chouhan J S

Fatigue life prediction analysis of surface cracked straight pipes
Transactions of The Indian Institute Of Metals
62, 3, 2009, 191-195

Saxena S, Ramakrishnan N, Dutta B K

Determination of stretch zone width using FEM
Engineering Fracture Mechanics
76, 7, 2009, 911-920

Temel H A, Bozkurt V, Majumder A K

Selective Oil Agglomeration of Lignite
Energy & Fuels, 23, 1, 2009, 779-784

Saxena S, Ramakrishnan N, Chouhan J S

Assessing fracture behaviour of circumferentially TWC elbows subjected to closing and opening moment
Nuclear Engineering and Design
239, 1, 2009, 9-15

Singh I B, Mandal D P, Singh M, Das S

Influence of SiC particles addition on the corrosion behavior of 2014 Al-Cu alloy in 3.5% NaCl solution
Corrosion Science, 51, 2, 2009, 234-241

Xu HY, Prasad M, He XL, Shan LW, Qi SY

Discoloration of Rhodamine B dyeing wastewater by schorl-catalyzed Fenton-like reaction
Science in China Series E-Technological Sciences, 52, 10, 2009, 3054-3060

Xu HY, Prasad M, Liu Y

Schorl: A novel catalyst in mineral-catalyzed Fenton-like system for dyeing wastewater discoloration
Journal of Hazardous Materials
165, 2009, 1186-1192

Visits Abroad 2009-10

S.No.	Name	Country	Duration	Programme
1	Dr. Anil K. Gupta Director	Germany	01.09.2009 04.09.2009	Collaboration with GKSS Research Center
2	Dr. Navin Chandra Scientist G	USA	14.03.2010 19.03.2010	International Conference
3	Dr. S. Das Scientist F	Switzerland	25.06.2009 07.07.2009	Training Program
4	Dr. J.P. Barnwal Scientist F	Russia	13.05.2009 15.05.2009	International Organizing Committee of World Mining Congress
5	Dr. Mohini Saxena Scientist F	Russia	21.11.2009 01.12.2009	DST Delegation
6	Dr. S.S. Amritphale Scientist F	Germany	15.09.2009 14.11.2009	DAAD Fellowship
7	Dr. R.K. Morchhale Scientist F	Singapore	01.06.2009 07.06.2009	Training Program at Proceq
8	Dr. Murari Prasad Scientist E-II	Greece	20.05.2009 24.05.2009	4th International Symposium on Environment
9	Dr. S.K. Sanghi Scientist E-II	Sweden	25.05.2009 29.05.2009	Inspection and Training visit
10	Dr. I. B. Singh Scientist E-II	Canada	31.05.2009 05.06.2009	8th Pacific Conference on Ceramic and Glass Technology
11	Dr. D.P. Mondal Scientist E-II	Italy	20.06.2009 24.06.2009	International Conference on Advanced Computational and Experimental Engineering (ACE-X-2009)
12	Mr. S.S. Waghmare Scientist C	Singapore	01.06.2009 07.06.2009	Training Program at Proceq

Awards & Recognitions 2009-10

S.No.	Name of Scientist	Details of Award/Recognition
1	Dr. Anil K. Gupta Director	Board of Directors, M/s. Shivam Autotech Ltd. A group of Hero Honda, Gurgaon and Haridwar Chairman – Technical Advisory Committee, Department of Drinking Water Supply, Ministry of Rural Development, Govt. of India Member - Program Advisory Committee (PAC) on Fly ash, Dept. of Science & Technology, New Delhi Member - Selection Committee of Young Engineer & Innovative Students Award of Indian National Academy of Engineering (INAE) Cluster Director – Engineering Science Cluster of CSIR Chairman – Indian Institute of Metals (IIM), Bhopal Chapter Management Council Member for National Environment Engineering Research Institute (NEERI) and Central Mechanical Engineering Research Institute (CMERI) Member - National Expert Committee on Flow Forming, Dept. of Space, Govt. of India, Trivandrum
2	Dr. R.K. Morchalle, Mr. M.D. Goel and Dr. A.H.Yegneswaran	Surendranath Mukherjee Memorial Prize for the paper published in Civil Engineering Journal of Institution of Engineers (I)
3	Dr. S.A.R. Hashmi Mr. Akram Khan Mr. S. Murali Dr. M.J.Nandan	Certificate of Merit – CSIR Leadership Development Program
4	Ms. Meenakshi Sharma, SRF	Young Scientist Award in the area of Chemical Sciences M.P. Council of Science & Technology

Memorable
OCCASIONS

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CSIR-AMPRI

Technology Day Celebrations 2009

Technology Day was celebrated on May 11, 2009 at CSIR-Advanced Materials and Processes Research Institute (AMPRI), Bhopal to commemorate the momentous accomplishments of Science and Technology. At the outset, Dr. A.H.Yegneswaran, Scientist G, AMPRI welcomed the guests and introduced the event.

Dr. Anil K. Gupta, Director, AMPRI, Bhopal in his address underlined the importance of the event and highlighted the technologies developed by AMPRI. He said that the Institute-Industry interaction is to materialize on a large scale and the R&D laboratories should engage in development of technologies/ products which are cost-effective, reliable, reproducible and are directly relevant to Indian industries. With these parameters, R&D laboratories could be made innovative and many more success stories of technology transfers are possible.

Technology Day Celebrations 2009

The Chief Guest of the programme Prof. Vinod Kumar Singh, Director, Indian Institute of Science Education and Research (IISER), Bhopal delivered a lecture on “Bio-inspired Systems”. In his lecture, he brought out nature's peculiar traits and bio-mimetic technologies. He further said that materials science is very important for our country and AMPRI and IISER can have strong collaborations. Mr. P.D. EKbote, Scientist G, AMPRI introduced the Chief Guest. The Guest of Honor, Dr. S.D. Kulkarni, Acting Director, CIAE, Bhopal in his presentation on “Agricultural Engineering Technologies and their role in Indian Agriculture” highlighted agri-business, rural based agro-processing and other technologies. He also underlined the ongoing collaborative work between AMPRI and CIAE. Dr. Navin Chand Scientist G proposed the vote of thanks. An exhibition on the R&D achievement of AMPRI was on display during the occasion.

Dr. Anil K. Gupta, Director, CSIR-AMPRI Presenting a Memento to the Chief Guest Prof. Vinod Kumar Singh

CSIR Foundation Day Celebrations - 2009

The 67th CSIR Foundation Day was celebrated on September 26, 2009 at AMPRI, Bhopal. Prof. S. K. Joshi, Former DG, CSIR was the Chief Guest of the occasion and delivered the foundation day lecture. He said that the present day expectations are very high and AMPRI must carve out a niche in Advanced Materials Science which should have a clear visibility in the society. He further emphasized that the laboratory should develop world class technologies and strengthen its basic research capabilities. Dr. Anil K. Gupta, Director, AMPRI delivered the welcome address. He recalled the contributions of Pandit Jawaharlal Nehru and Dr. S.S. Bhatnagar for establishing the CSIR and its contributions to various sectors of scientific and industrial research in our country. He emphasized that the laboratory should reposition and reorient according to its name change and focus on societal, industrial and strategic sectors.

CSIR Foundation Day Celebration 2009

On this occasion the staff members who were superannuated and had completed 25 years of service in CSIR were felicitated. Studentship awards were given to the children of AMPRI staff who have excelled in Board Examinations in the Science subjects.

Chief Guest Prof. S.K. Joshi distributing Studentship awards

CSIR-AMPRI Bhopal organized the Second Technical Poster Presentation by Young Researchers on September 18, 2009. The presentation was exclusively for Project Assistants/Research Fellows/Interns of AMPRI Bhopal and 38 poster papers were presented by young researchers. The Poster presentation was inaugurated by Dr. P. K. Verma, Director General, MAPCOST and Dr. Anil K. Gupta, Director AMPRI. On this occasion Dr. H.P. Garg, Ex. DG, MAPCOST and Dr. K. Basu Retd. Scientist G, AMPRI Bhopal were present. Awards for the best poster presentations were distributed during the CSIR Foundation Day on September 26, 2009.

An exhibition on “R&D Achievements” of AMPRI was organized on September 23, 2009. The exhibition is annually organized as a part of CSIR Foundation Day Celebrations and is open to all.

Dr. G. Sundararajan, Director, International Advanced Research Centre (ARCI), Hyderabad and Chairman, Research Council, AMPRI, Bhopal inaugurated the exhibition. Dr. Anil K. Gupta, Director, AMPRI and other scientists were present on the occasion. Students from local schools, colleges and visitors saw the exhibits and displays and evinced keen interest in research projects on light weight aluminium foam, x-ray shielding materials, sisal fiber technologies and alternate building materials.

Dr. G. Sundararajan, Chairman, RC inaugurating the CSIR foundtation Day Exhibition

School Children visiting the CSIR Foundation Day

National Science Day

National Science Day was celebrated on February 26, 2010 at AMPRI. This day is celebrated every year to commemorate the discovery of 'Raman Effect' by eminent scientist, Sir C.V.Raman. Dr. Anil K. Gupta, Director, CSIR-AMPRI while speaking on this occasion highlighted the importance of this celebration and informed that this celebration is very important as it reminds us of the importance of science in the societal transformation. He exhorted the scientific community to remain dedicated towards the cause of scientific and technological growth of the country. Dr. Navin Chandra, Scientist G, introduced the guests.

In his address on the occasion the Guest of Honor Mr. Sanjay Shukla, IAS, Chairman and Managing Director, MP Madhya Kshetra Vidyut Vitaran Company Pvt. Ltd. , Bhopal said that the scientific community should keep in mind to work for the society and they should collaborate to solve the day- to- day problems of the society.

On this occasion, a National Science Day Lecture was delivered by invited guest Dr. Krishan Lal, FNA, INSA Senior Scientist and Former Director, National Physical Laboratory, New Delhi on "X-Ray Differaction: A Powerful Tool for Materials Characterization ". In his lecture, he underlined the basics, applications and dynamical theory of X-Ray diffraction.

Dr. Krishan Lal, Chief Guest delivering the National Science Day lecture

The Biennial Report of the Institute for the period 2007-09 was released by Mr. Sanjay Shukla. Dr. C.B.Raju, Scientist G proposed the vote of thanks.

Mr. Sanjay Shukla, Guest of Honor and Dr. Anil K. Gupta releasing the Biennial Report of CSIR-AMPRI, Bhopal

35th Research Council Meeting

The 35th Research Council Meeting of AMPRI was held on September 23, 2009. The meeting was also attended by all Senior Scientists, Projects Leaders of the institute. Dr. Anil K. Gupta, Director, AMPRI has made a comprehensive presentation of AMPRI vision, strategy, action plan and road map. Presentations were also made by the project leaders of the ongoing projects about the progress and future course of action. After the meeting, an interactive session was held where the Chairman and members interacted with Scientists and Technical Officers of the laboratory.

35th Research Council Meeting

Inauguration of New Entrance Gate

CSIR-AMPRI, Bhopal has recently completed the construction of its new main entrance gate with its new name "CSIR-AMPRI" after the name change of the laboratory. The new entrance gate was inaugurated by Dr. G. Sundararajan, Director, International Advanced Research Centre (ARCI), Hyderabad and Chairman Research Council, AMPRI, Bhopal on September 22, 2009. Dr. Anil K. Gupta, Director, AMPRI; RC Members and staff of AMPRI were present during the inauguration.

New Entrance Gate of CSIR-AMPRI, Bhopal

Dr. G. Sundararajan, Chairman, RC, inaugurating the New Entrance Gate of AMPRI

36th Research Council Meeting

The 36th Research Council Meeting of AMPRI was held on March 19, 2009. The meeting was attended by all Senior Scientists, Projects Leaders of AMPRI. Dr. Anil K. Gupta, Director, AMPRI has made a comprehensive presentation of AMPRI`s R&D activities and way forward. Presentations were also made by the project leaders of the ongoing projects about the progress and future course of action. The Chairman and Members of the Research Council discussed the progress made by the institute under various R&D areas .

36th Research Council Meeting

Inauguration of Lightweight Materials Processing Laboratory

CSIR-AMPRI, Bhopal recently completed the construction of "Lightweight Materials Processing Laboratory" that houses equipment procured under CSIR Eleventh Five Year Plan network project. Pressure Die Casting Machine, Ultra Sonic Vibrator, Furnace for Semi Solid Processing, Protective Atmospheric Drop down Heat Treatment Furnace are some of the facilities in the new laboratory. Dr. G. Sundararajan, Director, International Advanced Research Centre (ARCI), Hyderabad and Chairman Research Council, AMPRI, Bhopal inaugurated the laboratory on March 19, 2010.

Dr. G. Sundararajan inaugurating Inauguration of Lightweight Materials Processing Laboratory

RC Members visiting the Lightweight Materials Processing Laboratory

Review Meeting of RSP Projects May 15, 2009

CSIR-RSWNET projects were identified and initiated under XI Five Year Plan aiming at the upliftment of these target groups through introduction of S&T in the contemporary and traditional practices relating to their day-to-day lives. Presently CSIR is working on 37 such rural supported projects in its 18 laboratories catering to vast areas like Agriculture, Drinking Water, Leather, Building Materials, Natural Fibers, Ceramics and Medicinal & Aromatic Plants.

The two-day Monitoring Committee Meeting of RSWNET projects was organized at AMPRI during May 15-16, 2009. During the inaugural session, Dr. Anil K. Gupta, Director, AMPRI said that these projects and technologies are meant for the upliftment of the rural people. These technologies should be economic and comparable to existing technologies. As per the agenda "CSIR-800" conceived by DG, CSIR, 800 million people are expected to be benefitted by CSIR technologies.

In his opening remarks, Dr. P.S. Ahuja, Director, IHBT, Palampur and Chairman, RSWNET Monitoring Committee said that rural technologies are a two dimensional situation, one is from product end and other is from resources end and a good balance between both the ends is essential. Under the RSWNET activity, AMPRI has taken up a mission mode program on Sisal Fiber Technologies for creating Sustainable Employment in rural areas. In addition to this, the institute is largely disseminating CSIR Rural Technologies.

2nd Review Meeting of CSIR RSWNET Projects

New EQUIPMENT FACILITIES

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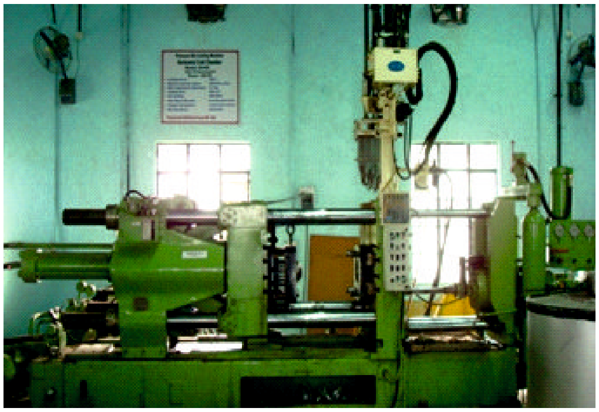
CSIR-AMPRI

Processing Facilities

Horizontal Cold Chamber Pressure Die Casting Facility

- Locking Force — 400 T
- Material Injection Speed — 300-500 cm/sec
- Shot Capacity for Aluminum — 2.7 Kg
- Casting Area — 400 cm^2
- Die Heating — 200-400^{o}C
- Shot Sleeve Diameter — 40 mm,50 mm, 60 mm, 65 mm
- Plunger Tip Diameter — 40 mm,50 mm, 60 mm and 65mm
- Die Coat Spray — Automatic



Controlled Atmosphere Computer Controlled Heat Treatment Furnace

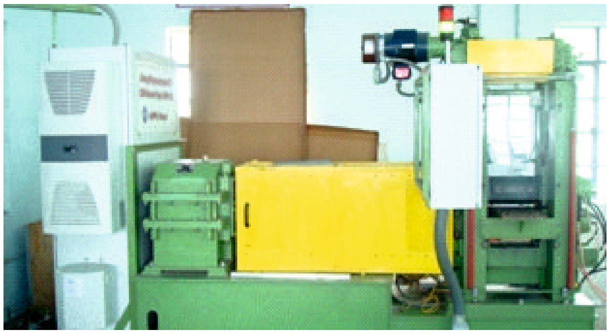
- Temperature — 1200°C
- Operation — Top feeding and bottom quenching facility
- Atmosphere — Air/Inert
- Materials — Heat treatment of Al, Mg, Zn alloys and composites, and steels

Magnesium Melting Facility

- Capacity — 30 Kg
- Maximum Temperature — 1000°C
- Melting Practice — Fluxless
- Controlled Atmosphere — Gas mixing and purging facility
- Hydraulic Tilting Facility — 160°

Hot and Cold Rolling Mill

- Roll Dimensions — 165 mm Φ x 250 mm
- Roll Speed — 7.6 m/min
- Maximum Roll Gap — 60 mm
- Minimum Thickness — 1.5 mm
- Maximum Billet Width — 150 mm
- Maximum Roll Temperature — 400°C
- Separating Force — 75,000 Kg
- Power — 18.65 KW
- Material to be Rolled — Al, Mg, Zn alloys and composites



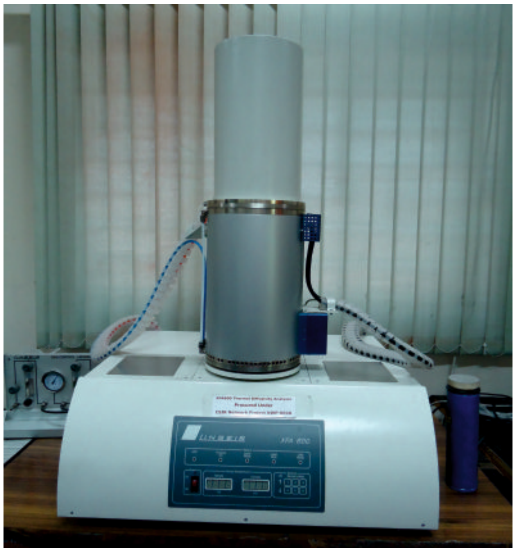
Characterization Facilities

Universal Testing Machine

• Load	100 KN
• Actuator Stroke	±75 mm with built in LVDT
• Test Space	Height : 1279mm Width : 664 mm
• Testing Speed	±220 mm /s
• Furnace	RT-600 °C
• Grips	Hydraulic wedge grip (Width: 50mm, Thickness: 15.7 mm) Round Specimen: 6-16 mm dia
• Tests	Tensile, Compression, Flexural, Low Cycle & High Cycle Fatigue, Fracture Mechanics
• Control	Computer controlled using Bluehill Software
• Materials for analysis	Metals, Alloys, Composites, Ceramics, Polymers

Thermal Conductivity Meter

• Temperature Range	RT-600 °C
• Thermal Diffusivity Range	0.001-10 cm^2/s
• Thermal Conductivity Range	0.1- 500 W /m.k
• Light Source	Xenon flash lamp
• Furnace	RT-700 °C
• Heating Rate	5-20 °C/min
• Atmosphere	Vacuum and inert atmosphere
• Materials for analysis	Metals, Alloys, Composites, Ceramics Polymers
• Control	Computer controlled using Xenon flash software



Contact Angle Measuring System

- Temperature up to 1200°C
- Vacuum (10-2 millibar) and inner gas control
- Contact angle and surface tension measurement as a function of temperature
- Sesile drop technique with video capturing facility

Pin-on-disc Sliding Wear Testing Machine

• Application	Sliding wear tests in dry and lubricated conditions
• Applied Load	Up to 200 N
• Speed	0.3-10 m/s

Characterization Facilities

Nano Imprint Lithography

• Application	Fabrication of patterns on nano meter scale using polymers
• Operating • Temperature Limit	Replicating substrate with nanometer dimension

Fibre, Fabric and Composites Testing Machine (5 KN)

ANNEXURE

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Staff News

Assessment Promotions

1.	Dr. S. Das	Scientist F to G	Gr.IV(5) to Gr.IV(6)
2.	Dr. A.K. Jha	Scientist F to G	Gr.IV(5) to Gr.IV(6)
3.	Dr. (Ms.) R. Dasgupta	Scientist E II to F	Gr.IV(4) to Gr.IV(5)
4.	Dr. R.K. Morchhale	Scientist E II to F	Gr.IV(4) to Gr.IV(5)
5.	Mr. R.S. Ahirwar	Scientist E I to E II	Gr.IV(3) to Gr.IV(4)
6.	Mr. A.K. Singh	Scientist E I to E II	Gr.IV(3) to Gr.IV(4)
7.	Mr. S. Murali	Scientist C to E I	Gr.IV(2) to Gr.IV(3)
8.	Mr. Sanjeev Saxena	Scientist C to E I	Gr.IV(2) to Gr.IV(3)
9.	Mr. N. Saha	TO C to E I	Gr.III(5) to Gr.III(6)
10.	Mr. T.S.V.C. Rao	TO B to C	Gr.III(4) to III(5)
11.	Mr. Ajay Kulshreshth	TO B to C	Gr.III(4) to Gr.III(5)
12.	Mr. M.K. Ban	TO B to C	Gr.III(4) to Gr.III(5)
13.	Mrs. S. Pal	Technician	Gr.II(2) to Gr.II(3)

Transfers

Mr. A.P. Rao, FAO transferred to CCMB, Hyderabad on 23.06.2009
Mr. Surendra Kumar, SO(G) transferred to CSIR HQ on 31.07.2009.
Mrs. N. Padma, COFA transferred on promotion to AMPRI from IICT, Hyderabad on 12.08.2009.

New Joining

Mr. Deepak Kumar Kashyap joined as JTA, Gr. III (1) on 22.2.2010
Mr. Muhamed Shafeeq M. joined as JTA, Gr. III (1) on 08.3.2010
Mr. Balwant Barkhaniya joined as JTA, Gr. III (1) on 08.3.2010
Mr. Anup Kumar Khare joined as JTA, Gr. III (1) on 12.03.2010

Sad Demise

Mr. P.N. Patil, Tech Gr. II (3) expired on 07.12.2009

Staff During the year Ending 31, March 2010

Group IV

Dr. Anil K. Gupta	Director
Dr. Navin Chandra	Sc. G
Dr. A.H. Yegneswaran	Sc. G
Dr. Navin Chand	Sc. G
Dr. C.B. Raju	Sc. G
Mr. P.D. Ekbote	Sc. G
Dr. A.K. Jha	Sc. F
Dr. S.P. Narayan	Sc. F
Mr. R.S. Solanki	Sc. F
Dr. S. Das	Sc. F
Dr. O.P. Modi	Sc. F
Dr. J.P. Barnwal	Sc. F
Dr (Ms) Mohini Saxena	Sc. F
Dr. B.K. Prasad	Sc. F
Dr. M.S. Yadav	Sc. F
Dr. S.S. Amritphale	Sc. F
Dr. Alok K. Gupta	Sc. F
Dr. (Ms.) Rupa Dasgupta	Sc. F
Dr. S.A.R. Hashmi	Sc. F
Dr. R.K. Morchhale	Sc. F
Dr. (Ms.) Swati Lahiri	Sc. F
Mr. K.K. Kaul	Sc. E-II
Dr. Murari Prasad	Sc. E-II
Dr. R K Rawlley	Sc. E-II

Dr. S.K. Sanghi	Sc. E-II
Dr. I. B. Singh	Sc. E-II
Dr. P. Asokan	Sc. E-II
Dr. D.P. Mondal	Sc. E-II
Dr. A.K. Majumdar	Sc. E-II
Mr. A.K. Singh	Sc. E-II
Mr. S.P. Pathak	Sc. E-I
Mr. S. Shrimanth	Sc. E-I
Mr. R.S. Ahirwar	Sc. E-II
Dr. J.P. Shukla	Sc. E-I
Dr. K. K. Pathak	Sc. E-I
Dr. Raghuvanshi Ram	Sc. E-I
Mr. Mohd Akram Khan	Sc. E-I
Mr. Manish Mudgal	Sc. E-I
Dr. (Ms) Deepti Mishra	Sc. E-I
Mr. H.N. Bhargaw	Sc. E-I
Mr. Sanjeev Saxena	Sc. E-I
Mr. S. Murali	Sc. E-I
Dr. M.J. Nandan	Sc. C
Mr. S.S. Waghmare	Sc. C
Mr. Sanjay K. Panthi	Sc. B
Mr. Meraj Ahmed	Sc. B
Mr. M. Das Goel	Sc. B
Mr. Gaurav K. Gupta	Sc. B

Group III

Mr. N. Saha	TO E-I
Dr.(Ms.) Anita Bhushan	TO C
Mr. R.K. Chauhan	TO C
Mr. P. Banerjee	TO C
Mr. M. Chandra	TO C
Mr. Ajay Naik	TO C
Dr. J.P. Pandey	TO C
Mr. H.N. Rao	TO C
Dr. E. Peters	TO C
Dr. V.Sorna Gowri	TO C
Mr. T.S.V.C. Rao	TO C
Mr. A. Kulshreshta	TO C
Mr. R. K. Soni	TO B
Mr. M.K. Jain	TO B
Mr. M.K. Ban	TO B
Mr. A. A. Bakhsh	TO B
Dr.(Mrs). P. Padmakaran	TO B
Mr. K.K. Rao	TO B
Ms. S. Gamad	STA
Mr. O. Chaurasia	JTA
Mr. D.K. Kashyap	JTA
Mr. Mhod. Shafeeq M	JTA
Mr. Balwant Barkhaniya	JTA
Mr. Anup Khare	JTA

Group II

Mr. A. H. Khan	Technician
Mr. U.M. Lakra	Technician
Mr. R.K. Kosthi	Technician
Mr. R.K. Gurjar	Technician
Mr. A. Yadav	Technician
Mr. Md. Rafique	Technician
Mr. M. L. Gurjar	Technician
Mr. A. Ullah	Technician
Mr. P.N. Patil	Technician
Mr. B. Patil	Technician
Mr. D. K. Singh	Technician
Mr. R.C. Malvi	Technician
Mr. G. S. Yadav	Technician
Mr. A. Saxena	Technician
Mr. A.K. Asati	Technician
Mr. S.K. Suryavanshi	Technician
Mrs. S.Pal	Technician
Mr. R. Kishore	Technician

Group I

Mr . R.D. Kushwaha	Technician
Mr . B.L. Pradhan	Technician
Mr . L.N. Mehra	Technician
Mr . L.N. Sahu	Technician
Mr . S.K. Batham	Technician
Mr . S.K. Raikwar	Technician
Mr . N.S. Jadav	Technician
Mr . Indraj Yadav	Technician
Mr . Devilal Rathore	Technician
Mr . Anil Gond	Technician

Administration

Mr. S.K. Gupta	Controller of Administration (COA)
Mrs. N. Padma	Controller of Finance & Accounts (COFA)
Mr . P. K. Shrivastava	Protocol Officer
Mr . S. Majumdar	SO (General)
Mr . D.P. Singh	SO (S&P)
Mr . P. K. Sinha	SO (F&A)
Mr . G. Chand	SO (F&A)
Mr. A.K. Jain	SO (Establishment)
Mrs. S. Soman	Private Secretary
Mrs. M. Surendran	Private Secretary
Mr . B. Divakar	Security Officer
Dr. (Mrs) M. Dubey	Sr. Hindi Tran.
Mr. N. Vishwanathan	Sr. Steno
Mrs. S. Vijayan	Sr. Steno
Mr. D.M. Chilbule	Assistant (S&P) Gr.I
Mr. P.K. Satyanesan	Assistant (General) Gr.I
Mr. J. Kujur	Assistant (General) Gr.I
Mr. S. Vinodia	Assistant (F&A) Gr.I
Mrs. A. Vinodia	Assistant (General) Gr.I
Mr. N.K. Pethari	Assistant (General) Gr.I
Ms. A. Daniel	Receptionist (Isol.Post)
Mr. H. Singh	Astt. (G) Gr.II
Mr. V. Shrivastava	Astt. (G) Gr.II
Mr. S. Bhawsar	Jr. Hindi Translator
Mr. G. K. Dhakad	Jr. Steno
Mr. V. Nathiley	Asstt. (S&P) Gr.II
Mrs. T. Rangari	Record Keeper
Mr. K.P. Tripathi	Jr. Security Guard
Mr. R.N. Pradhan	Jr. Security Guard
Mr. B. Gurung	Jr. Security Guard
Mr. D. Prasad	Tea & Coffee Maker
Mr. Dayaram	Safaiwala
Mr. R.C. Pillai	Chowkidar
Mrs. A. Golait	Peon

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गतिविधियाँ

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हिन्दी दिवस समारोह – 2009

प्रगत पदार्थ तथा प्रक्रम अनुसंधान संस्थान (एम्प्री), भोपाल में 14 सितंबर, 2009 को हिन्दी दिवस समारोह का आयोजन किया गया। इस अवसर पर संस्थान के वरिष्ठ वैज्ञानिकों, प्रशासन नियंत्रक सहित अनेकानेक स्टाफ सदस्य उपस्थित थे। समारोह की अध्यक्षता संस्थान के वरिष्ठ वैज्ञानिक डॉ. ए.एच. यज्ञेश्वरन द्वारा की गई।

समारोह के अध्यक्ष ने अपने उद्बोधन में कहा कि राजभाषा हिन्दी भारत संघ की कार्यालयीन कामकाज की भाषा है और इसकी उन्नति के लिए सभी स्टाफ सदस्यों को भरपूर प्रयास करने चाहिए, ताकि यह वैज्ञानिक, तकनीकी और कम्प्यूटर आदि क्षेत्रों में अच्छे से इस्तेमाल हो सके।

अध्यक्ष महोदय द्वारा संस्थान में 7-11 सितंबर 2009 तक चले हिन्दी सप्ताह में विजयी रहे प्रतिभागियों को भी पुरस्कृत किया।

हिन्दी सप्ताह–2009 की झलकियाँ

CSIR-AMPRI

हिन्दी कार्यशाला

प्रगत पदार्थ तथा प्रक्रम अनुसंधान संस्थान (एम्प्री), भोपाल में 19 नवम्बर 2009 को एक-दिवसीय राजभाषा कार्यशाला का आयोजन किया गया। कार्यशाला में संस्थान के प्रशासनिक अधिकारियों एवं कर्मचारियों ने प्रतिभागिता की।

श्री हरीश चौहान, अनुसंधान अधिकारी, राजभाषा विभाग, गृह मंत्रालय, भारत सरकार कार्यशाला में मुख्य अतिथि थे।

श्री चौहान ने स्टॉफ को संबोधित करते हुए राजभाषा के निर्धारण की पृष्ठभूमि पर प्रकाश डाला और अनुच्छेद के प्रावधानों को विस्तार से बताया। इसके अतिरिक्त उन्होंने राजभाषा कार्यान्वयन हेतु क्षेत्रवार कार्य की अनिवार्यताओं, धारा 3 (3) इत्यादि पर विस्तार से चर्चा करते हुए प्रतिभागियों की जिज्ञासाओं का समाधान किया तथा उन्हें राजभाषा में अधिकाधिक कार्य करने हेतु प्रोत्साहित किया।

तकनीकी हिन्दी कार्यशाला

प्रगत पदार्थ तथा प्रक्रम अनुसंधान संस्थान (एम्प्री), भोपाल में 05 फरवरी, 2010 को राजभाषा माध्यम से पदार्थ विज्ञान विषयक एक-दिवसीय वैज्ञानिक कार्यशाला का आयोजन किया गया। यह कार्यशाला हिन्दी में लिखे वैज्ञानिक शोध पत्रों पर केन्द्रित थी। इस कार्यशाला में इन शोध पत्रों को वैज्ञानिकों द्वारा प्रभावी और सरल तरीके से प्रस्तुत कर श्रोताओं की जिज्ञासाओं का समाधान किया गया। कार्यशाला के समन्वयक डॉ. एस.ए.आर. हाशमी, वैज्ञानिक ने प्रारंभ में कार्यशाला के उद्देश्य पर प्रकाश डाला।

डॉ. अनिल कुमार गुप्ता, निदेशक, एम्प्री कार्यक्रम में मुख्य अतिथि थे। डॉ. ए.एच. यज्ञेश्वरन, वैज्ञानिक जी ने तकनीकी सत्र की अध्यक्षता की।

डॉ. अनिल कुमार गुप्ता, निदेशक, एम्प्री कार्यक्रम के मुख्य अतिथि

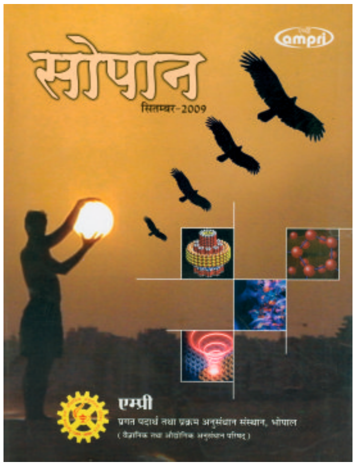
डॉ. अनिल कुमार गुप्ता, ने कार्यशाला का उद्घाटन करते हुए राजभाषा कार्यान्वयन की अनिवार्यताओं को रेखांकित किया और कहा कि हिन्दी में काम करना सरल है, इसे और अधिक बढ़ावा मिलना चाहिए।

डॉ. आलोक कुमार गुप्ता ने ''प्राचीन भारत का इस्पात'' और डॉ. मुरारी प्रसाद ने ''ग्रीन हाउस गैसों का प्रग्रहण'' विषयों पर शोध पत्र प्रस्तुत किए।

कार्यशाला का संचालन डॉ. मनीषा दुबे, वरिष्ठ हिन्दी अनुवादक और आभार प्रदर्शन श्री आर.एस. अहिरवार, वैज्ञानिक द्वारा किया गया।

सोपान

वार्षिक राजभाषा पत्रिका




प्रगत पदार्थ तथा प्रक्रम अनुसंधान संस्थान
ADVANCED MATERIALS AND PROCESSES RESEARCH INSTITUTE
COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH

For further information & details please contact :

Dr. Anil K. Gupta, Director

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Council of Scientific and Industrial Research, Hoshangabad Road, Bhopal, 462 064 M.P.
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