WELDING RESEARCH IN INDIA – CURRENT INTERESTS
AND FUTURE DIRECTIONS

Baldev Raj, M. Vasudevan and A.K. Bhaduri
Indira Gandhi Centre for Atomic Research,
Kalpakkam – 603102, Tamilnadu, India
E-mail: bhaduri@igcar.gov.in
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ABSTRACT

Innovative developments in welding technologies and processes are required to achieve both greater productivity and enhanced quality of components manufactured by the welding industry. In India, through sustained efforts by researchers, academicians and technologists, significant progress has been made in understanding various arc welding processes, weldability testing, repair welding of power plant components, non-destructive evaluation of welds, consumable development, understanding microstructural evolution and correlating the microstructures with properties and performance of the welds.

Developments in the science and technology of welding, across the globe, have reached a stage where welding processes based on scientific principles are being designed to tailor the composition, microstructure and properties for the requisite performance of the weld. India is in a unique position to accelerate focus on her research programmes to become leaders in developing newer welding processes and technologies. Major thrust is being given in research and development in the priority areas such as flux assisted GTAW, laser welding, friction stir welding, hybrid welding processes, intelligent welding and automation, development of NDE sensors, development of weld process models, development of techniques for measurement and analysis of residual stresses and control of distortion etc.

The mantra for success in developments is through interdisciplinary collaboration among scientists and technologists working in the industry, academia, research centres and national laboratories. The focus and purpose are essential ingredients to be competitive and excellent in achieving results. The Indian experiences towards building robust technology based on sound scientific approach are discussed.

CHARACTERIZATION OF LONG TERM CORROSION PRODUCT ON A CHALCOLITHIC PERIOD COPPER AXE

A. Srivastava, R. Balasubramaniam, and V. N. Misra*
Department of Materials and Metallurgical Engineering, Indian Institute of Technology, Kanpur 208 016, India
*G-2, B Wing, Ganga Park, Mundhwa Road, Pune 411036, India
E-mail: bala@iitk.ac.in
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ABSTRACT

The long term corrosion scale on a 3800-years old soil-buried copper object has been analyzed. The outer region of the scale is rich in sulfate while the region near the metal-scale interface is primarily composed of cuprite.
A FRACTURE STUDY OF DIFFUSION BONDED Ti$_6$Al$_4$V AT ROOM TEMPERATURE

Rahul Basu and P.C. Angelo*
GTRE, Bangalore 560 093, INDIA
* MTRC, PSG College, Coimbatore 641 004, INDIA
E-mail: rahulbasu@mail.gtre.org
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ABSTRACT

Diffusion bonded specimens of Ti$_6$Al$_4$V were prepared as tensile test specimens by EDM wire cutting. Fracture tests were performed at room temperature, with a microtensometer. Fracture surfaces were examined as is optically under SEM with a JEOL 6360. Slip lines were apparent on the surface with some porosity at higher stresses. Data from earlier measurements on stress and bonded area ratio were compared with various theories. A refined empirical relation was obtained.

USING HIGH POWER MICROWAVES FOR HEAT TREATMENT OF LARGE METALLIC SAMPLES OF P91 STEEL

Kulvir Singh, G Jaipal Reddy, K S Reddy and G Swaminathan*
Metallurgy Department, Corporate R&D, BHEL, Hyderabad – 500 093, India
* Ceramic Technological Institute, EPD, BHEL, Bangalore – 560 012, India
Email: kulvir@bhelrnd.co.in
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ABSTRACT

X10CrMoVNb 9 10 (P91) steel is being used in sub critical and supercritical boiler pipes (P91), headers and tubes (T91) for the past many years. This steel is also used extensively in welded condition. Generally, these steels are being heat treated by using conventional heat treatment furnaces for getting desired properties. The P91 steel samples were heat treated in the temperature range of 1073 to 1573 K as these temperature are normally experienced in the heat affected zone (HAZ) during welding. The aim of this study is to prove that the similar or better uniform properties are being achieved by heat-treating large steel samples in the high power hybrid microwave (MW) furnace. It is also possible to heat treat steels uniformly at various temperature ranges using high power microwave energy. Till now, generally microwave furnaces are industrially used for sintering purposes i.e heating of ceramics, metal powder, powder metal composites etc only. As per the studies, the metals reflect microwaves i.e they are very poor absorbers of microwaves, so they cannot be heat-treated directly in the microwave field. Microwave technology heats the metal indirectly, avoiding the electrical arcing and magnetron destruction that are expected in heating a metal in a microwave oven. The system encloses the metal component within a ceramic insulating cavity containing microwave-absorbing plasma. The plasma heats the metal and this technology works quickly. It can reduce cycle time by two-thirds compared to the conventional heating process and also requires less energy to heat the object compared to a conventional furnace as only the object is heated by microwave radiation and there is no loss of energy in heating the total furnace volume. This results in huge savings in terms of time and money.
THE EFFECT OF AGEING TIME ON MICROSTRUCTURE AND MECHANICAL PROPERTIES OF ALUMINIUM ALLOY A356

Jyoti Menghani and Bharat Joshi
Metallurgical Engineering Department, M.S.University of Baroda, Baroda.
E-mail: barat_jo@rediffmail.com
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ABSTRACT

Reduced weight of automobiles for the purpose of fuel economy has encouraged the use of Al alloys in wheels. Alloy A356 (LM25) containing 7% Si & 0.3%Mg is widely used for its favourable properties such as excellent castability, good corrosion resistance, good pressure tightness etc. It is medium strength heat treatable hypoeutectic alloy. During solidification excess Si-Al eutectic appears as second phase. In case of A356, precipitates of Mg$_2$Si are formed which are responsible for hardening. The precipitation sequence observed in A356 is $\alpha_{eq} \rightarrow$ GP Zone $\rightarrow \beta'' \rightarrow \beta' \rightarrow \beta$ (Mg$_2$Si). In present work, A356 alloy is solution treated (550 $^\circ$C) for 5 hours, quenched in water so as to get super saturated solid solution (SSSS) then subjected to ageing at various time intervals of 4,8,12,16,20 hours at fixed temperature (170 $^\circ$C). The purpose is to determine optimum ageing time using different characterizing methods like hardness, microstructural observation & electrical conductivity.

SULPHUR CONTROL OF BLAST FURNACE HOT METAL BY MANGANESE ADDITIONS

G. K. Mandal, (Late) N. K. Batra* and S. P. Mehrotra
National Metallurgical Laboratory, Jamshedpur - 831007, Jharkhand, India.
*Indian Institute of Technology, Kanpur– 208016, U.P., India
E-mail: mandalgk@yahoo.com
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ABSTRACT

This investigation deals with experimental determination of solubility of sulphur in Fe-C-Mn melts in the temperature range of 1473 to 1673 K. Such temperatures occur during the transit of hot metal from the blast furnace to the mixer in a steel plant. Sulphur content of the metal decreases with an increase in manganese content of the metal at a constant temperature or with a decrease in the temperature at constant Mn level of the bath. Thermodynamic data are used to calculate the equilibrium value of sulphur as a function of temperature and Mn content. The activity of MnS is near unity in absence of any other desulphuring agent, but it decreases with addition of certain fluxes often needed to produce a liquid slag layer. Experiments are designed to study the effect of slag chemistry on sulphur content of the metal at various Mn levels. A mathematical model based on mass and enthalpy balances in the lower part of the blast furnace is developed to determine the required iron ore and coke rate at different manganese levels of the hot metal.
REACTION KINETICS STUDIES ON TI-48AL SYSTEM TO OBTAIN ACTIVATION ENERGY AND AVRAMI INDEX BY JOHNSON – MEHL – AVRAMI EQUATION

Bhanu Pant, Vijaya Agarwala*, R. C. Agarwala* and P. P. Sinha
Vikram Sarabhai Space Centre, Trivandrum – 695 022
*Indian Institute of Technology, Roorkee, Roorkee – 247 667
E-mail: bhanupant2000@gmail.com
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ABSTRACT

Gamma titanium aluminides are identified as high performance materials for aerospace sector for applications in the vicinity of 1000ºC. Reaction synthesis (RS) route based on powder metallurgical technique is being pursued for developing these aluminides due to main advantages of avoiding elemental segregation, fracturing, elemental loss and near net shape processing. In the RS route, heat of reaction between elemental powders is utilised to obtain intermetallic material. Hence, reaction kinetics studies are important for various RS systems. In gamma titanium aluminides, Ti-48at%Al composition is identified as base composition for further alloy development. In the present paper activation energy and kinetics parameter Avrami Index ‘n’ are obtained for Johnson – Mehl – Avrami (JMA) equation for the non – stoichiometric reaction relating to this non-stoichiometric composition. The present work is based on the work on non – isothermal crystallization kinetics of metal glasses by J.M. Criado and A. Ortega 5.

REASSESSMENT OF ALUMINIUM–BISMUTH (Al-Bi) PHASE BOUNDARY

Sanjay Chaubey
Department of Physics
Motilal Nehru National Institute of Technology, Allahabad-211004
Email: chaubey55@yahoo.com
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ABSTRACT

Al-Bi is a simple binary system possessing liquid unmixing below a critical temperature. Using Flory’s solution model for liquid phase and analytical expressions or experimental data for the existing solid phases, the computer generated phase diagram places the monotectic point at =930K and 0.43 at. % Bi. The critical point is located at 1310K and 20.34 at. % Bi.