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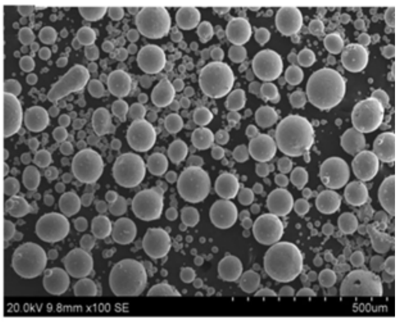
Small-scale mechanical testing of materials

Small-scale mechanical testing of materials has gained prominence in the last decade or so due to the continuous miniaturization of components and devices in everyday application, as also the need to look deeper into the material microstructure for better understanding. Although many materials in devices are used for their functional capabilities, they also have to resist mechanical loads in some form or the other to prevent premature failure. The development in the field of nano/micro-mechanics has also been shaped by advances in characterization techniques, which allow us to see things at the nano-scale and below, today. Both the intrinsic material length scale and the external size of the specimen have an influence in the mechanical response of the material. Jaya and Alam (**page 1073**) review all the new techniques that have been developed to mechanically probe materials at the small length scales, to determine how properties like yielding, fracture, residual stress and creep vary from those at the bulk. To illustrate their use in applications, a few case studies specific to both current materials in use as well as future materials with potential to be used, have also been given. An outlook of where the field is headed, including facilities being established at both the Defense Metallurgical Research Laboratories and the Indian Institute of Science, is also given.

Oxide dispersion strengthened steels

Oxide dispersion strengthened (ODS) steels are being considered as structural materials in nuclear reactors (fast and fusion rectors) and ultra super critical thermal power plants in view of their outstanding high temperature properties and resistance to oxidation, corrosion and irradiation. Yttria dispersed ferritic-martensitic and ferritic steels exhibit better mechanical behaviour than the base materials due to the presence of 10–20 nm sized Y_2O_3 particles. Addition of titanium to Y_2O_3 strengthened ODS steels refines the dispersoid size to 2–6 nm and substantially increases the number density by forming Y–Ti–O complex oxides resulting in further increase in elevated temperature strength and resistance to creep and irradiation. The oxidation and corrosion resistance of ODS steels can further be improved by increasing chromium content beyond 9 wt%.

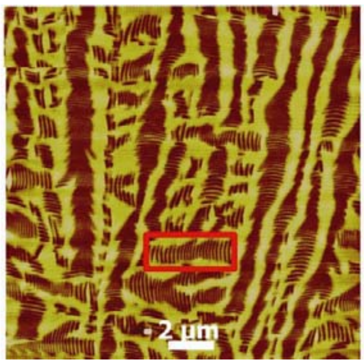
The International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI) has embarked on a major programme to produce ODS steels (with Ti) having 9, 14 and 18 wt% chromium for clad tubes of fast breeder reactors, blades for ultra supercritical steam turbines and structural components of fusion reactors. An inert gas atomizer to produce steel powders of various compositions, Zoz high energy mechanical mill to disperse oxides in steel powders, canning and hot extrusion facilities to consolidate the ODS steel powders were established at ARCI and extensively used to develop different steel grades.



Sundararajan *et al.* (**page 1100**) present the efforts of ARCI towards the development of 9Cr ferritic-martensitic and 18Cr ferritic ODS steels with particular emphasis on their microstructural and mechanical properties.

Complex oxides

Ramesh (**page 1107**) presents a review of some salient aspects of a broad class of functional materials, namely complex oxides. These materials, exemplified by the rare earth manganites, superconducting cuprates and more recently multiferroics, are characterized by a complex crystal chemistry, that is central to competing/cooperating spin, charge, orbital and lattice degrees of freedom. A fundamental defining feature of such materials is the complex nanoscale phase coexistence that appears to be central to the appearance of large responses. The emergence of pulsed laser deposition as a tool to create artificially engineered heterostructures has provided researchers



with a powerful approach to create new states of matter at such heterointerfaces. This combined with modern X-ray, electron, neutron and proximal probes (such as conducting AFM, piezoresponse SPM, etc.) and *ab initio* theoretical studies has provided us with deep insight into the various physical phenomena that manifest themselves in such materials.

Polymer solar cells

Solar cells have become the alternative renewable energy source for its ever growing demand. Presently commercialized crystalline silicon based solar cells are able to harness the solar energy but for a high cost, which comes from their processing. Organic solar cells on the other hand offer advantages in terms of low processing cost however their efficiency in terms of harnessing solar energy still low. Various research groups are following donor acceptor (DA) based approach for designing novel organic materials with high efficiency. In DA concept, electron deficient moiety is coupled with and electron donor to obtain conjugated organic polymer with low band gap. These low band gap polymers are capable of absorbing great breadth of solar spectrum hence enhance the efficiency. In this regard, Naik *et al.* (**page 1115**) have coupled donor type dithiophene (DTP) with acceptor type benzodithiophene (BZT) to get a low band gap copolymer and studied photo physical properties.