JOURNAL OF MATERIALS SCIENCE **39** (2004) 769–770

Editorial: Electrophoretic deposition: fundamentals and applications in materials science

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The potential of the electrophoretic deposition (EPD) technique for the realisation of unique microstructures and novel (and complex) material combinations in a variety of morphologies and dimensions is being increasingly appreciated by materials scientists. Although the basic phenomena involved in EPD are well-known and have been the subject of extensive theoretical and experimental research, there is general agreement in the scientific community that further R&D work needs to be done to develop a full, quantitative understanding of the fundamental mechanisms of EPD to optimise the working parameters for a broader use of EPD in materials processing. This is especially the case when, for example, multicomponent suspensions are used with the aim of fabricating complex or composite micro- and nanostructures. New application areas for EPD are the low-cost fabrication of composite materials including advanced coatings, nanocomposites, laminate structures, functional graded materials and fibre-reinforced ceramics. Furthermore, EPD of electroceramic particulate materials gives potential advances in a number of novel applications including piezoelectric devices, biomedical ultrasound probes, chemical sensors and solid oxide fuel cells. EPD is also an advantageous technology for the manufacture of small-scale, near net-shape objects having accurate dimensions (micro- and nano-manufacturing).

The First "International Conference on Electrophoretic Deposition: Fundamentals and Applications" was held in August 2002 in Banff, Alberta, Canada, under sponsorship of the United Engineering Foundation. This was the first conference focussing entirely on EPD and the main goal was to examine issues relevant to the EPD process both from the fundamental and the application points of view. At the conference a total of 48 presentations came from 11 different countries. The main topics of the meeting were:

- Advanced Experimental Techniques
- EPD in Ceramic Processing
- EPD Integrated Manufacturing Technologies
- Coatings
- Theory and Modelling
- Functionally Graded Materials
- EPD Applications in Solid Oxide Fuel Cell technology
- Ceramic Composites
- Nanostructured Materials and Films

The proceedings of the conference were published by the Electrochemical Society [1] and in view of its success and the enthusiasm generated in the EPD community it is intended to hold a second conference in 2005 in a European location. Further details of the next conference may be obtained from me at the above address.

Authors who presented papers at the conference dealing specifically with the application of EPD as a processing technique for the fabrication/processing of traditional or new materials were invited to participate in the present special section of the *Journal of Materials Science*.

The seventeen papers in this issue are thus a representative selection of research being carried out worldwide in the field, with papers both covering the fundamentals of the EPD technique, as applied in materials science, and those showing specific examples of application of the method in different materials and systems. The first paper by Talbot *et al*., reviews one of the classic fields of application of EPD, which is the deposition of phosphors for the processing of monochrome and colour screens for information displays. This is followed by a paper by Van der Biest *et al*., who present a new analytical model of the EPD process with particular emphasis on the issue of increasing electric resistance of the growing deposits. The paper also includes a comprehensive consideration of factors affecting the shaping of free standing objects by EPD. In the next paper, Fukada *et al*., present a comprehensive treatment of the EPD technique and its applications in materials processing, with a special discussion of the basic deposition mechanisms and addressing a number of issues and open questions remaining in the literature. Tabellion and Clasen revisit their long-standing interest in EPD from aqueous suspensions, reviewing the application of the technique for near-shape manufacturing of advanced ceramics and glasses, while the selection of charging agents

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for successful EPD of ceramic particles is shown by Zarbov *et al*. The next paper by Sarkar *et al*., is concerned in general with the use of EPD for fabricating high-performance ceramics, including reaction bonded aluminium oxide and components for micro-solid oxide fuel cells. The electrophoretic deposition of electrolyte materials for solid oxide fuel cells (SOFCs) is further discussed for a variety of systems in the paper by Zhitomirsky and Petri, while Negishi *et al*., describe a comprehensive experimental study on the use of EPD for production of yttria stabilised zirconia deposits for SOFCs. EPD is widely used for production of ceramic and composite coatings and a series of papers in this special section deal with this subject. These include the papers on ceramic-metal coatings on stainless steel by Krueger *et al*., thick silica coatings on metal substrates by Castro *et al*., and titania coatings on carbon and SiC fibres by Boccaccini *et al*. In a group of papers dealing with novel experimental techniques to produce unique microstructures on the basis of EPD, Uchikoshi *et al*., describe the fabrication of textured alumina by EPD in a strong magnetic field, Van Tassel and Randall report on the integration of EPD in the manufacture of multilayer electronic devices, and Put *et al*., describe an EPD based technique for production of symmetrically graded zirconia/alumina and WC/Co/Ti(C,N) discs. This series of papers finishes with the experimental study of Ordung *et al*., who show the use of EPD to deposit silicon powders onto carbon and SiC fibres in order to produce fibre reinforced silicon nitride matrix composites. Finally, the processing of novel nanomaterials is considered by Limmer *et al*., who present the growth of titania nanorods by sol-gel electrophoresis and by Matsuda *et al*., who use a combination of sol-gel and EPD to produce novel inorganic-organic films for micro-optical devices.

I am grateful to all authors and referees, who have supported this Special Section with their hard work, contributing to its timely publication.

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Reference

1. A. R. BOCCACCINI, O. VAN DER BIEST and J. TALBOT (eds.), in "Electrophoretic Deposition: Fundamental and Applications" (The Electrochemical Society, Pennington, US, 2002). (Proc. of the International Conference on Electrophoretic Deposition, held in Banff, Canada, 18–22 August 2002).