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PREFACE

Electrophoretic deposition: fundamentals and applications in materials science

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The Second ''International Conference on Electrophoretic Deposition: Fundamentals and Applications'' was held in June 2005 in Barga, Italy, under the auspices of Engineering Conferences International (ECI). This was the second conference focussing entirely on electrophoretic deposition (EPD), after the first conference in this series held in Banff, Canada in 2002 [1, 2]. The main goal was to provide a forum for discussion among scientists and technologists from varied disciplines on the subject of the EPD process, both from the basic science and the application point of view.

The potential of the EPD technique for the realisation of unique micro and nanostructures and novel (and complex) material combinations in a variety of morphologies and dimensions is being increasingly appreciated by materials scientists and technologists. 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 and quantitative understanding of the fundamental mechanisms of EPD. This is a requirement for the design of EPD methods based on optimised working parameters which should lead to 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 functional coatings, nanocomposites, laminate structures, functional graded materials, fibre-reinforced ceramics, bioactive coatings and carbon nanotube layers. Furthermore, EPD of electroceramic particulate materials leads to advances in a number of novel applications including piezoelectric devices, biomedical ultrasound probes, chemical sensors, capacitors 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).

At the conference a total of 60 presentations came from 14 different countries. The main topics of the meeting were:

- Advanced experimental techniques
- EPD in ceramic processing
- EPD integrated manufacturing technologies
- Nanostructured materials and films
- Theory and modelling
- EPD in Industrial applications
- Coatings
- EPD applications in solid oxide fuel cell technology
- Biomaterials and bioactive coatings

The proceedings of the 2005 conference were published recently [3] and in view of the success of this conference series and the enthusiasm generated in the EPD community it is intended to hold a third conference in 2008 in a location in North America. Further details of the next conference may be obtained from me at the address given on this page.

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Authors who presented papers at the conference last year, dealing specifically with the application of EPD as 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 *twenty one* 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 five papers focus on novel experimental techniques designed to gain insight into different aspects of the EPD mechanisms or to enhance the quality of the deposition. Van Tassel and Randall study the role of ion depletion in the EPD of alumina from ethanol while the EPD of different ceramics (including AlN and SiC) from tailored non-aqueous suspensions is investigated by K. Moritz and E. Mueller. Also working on non-aqueous suspensions, a complete impedance study on the EPD of yttrium disilicate is presented by Argirusis et al. The effect of different electrode materials, e.g. stainless steel, carbon, on EPD of yttria-stabilised zirconia is investigated in the paper by Hayashi et al. while Uchikoshi et al. present further developments on their process of EPD of alumina under high magnetic fields. The following group of six papers consider the application of EPD for fabrication of ceramic layers and coatings for specific applications in several areas ranging from piezoelectric devices (Chen et al.) to zirconia thermal barrier coatings (Van der Biest et al). Other interesting application fields of EPD are SiC fibre reinforced SiC ceramic composites for future fusion reactor materials, as presented by Novak et al., SiO_2–TiO_2 thick films for photocatalytic applications, as presented by Matsuda et al., and $YBa_2Cu_3O_{7-x}$ superconducting thick films, studied in the paper by Dusoulier et al. The engineering performance of EPD at industrial scale, considering problems and solutions, is comprehensively covered by Zarbov et al. They discuss the challenge of developing EPD processes suitable for mass production as opposed to demonstrations of laboratory feasibility studies. EPD is increasingly being considered as a processing technology in the biomedical materials field. In the next five papers in this issue the reader will find investigations on the novel application of EPD in two significant biomedical areas: dental biomaterials and bioactive coatings for implants. T. Moritz et al. present the application of EPD to produce ceramic dental crowns and bridges while Oetzel and Clasen investigate the preparation of zirconia dental crowns by EPD. Mayr et al. focus on the development of thin electrophoretically deposited hydroxyapatite layers on $TiAl_6V_4$ hip prostheses. Also in the field of bioactive coatings, the paper by Singh et al. demonstrates the use of EPD to deposit carbon nanotube containing ceramic coatings on biocompatible stainless steel plates and Boccaccini et al. show for the first time the suitability of EPD for the development of PEEK/Bioglass® composite coatings on shape memory alloy substrates.

The last group of papers covers the emerging application of EPD as a fabrication tool in the field of nanotechnology. Mahajan et al. investigate the EPD of europium oxide nanocrystalline thin films, while the electronic transport of dielectrophoretically grown nanowires from gold nanoparticles is presented by Harrower and Oliver. The EPD of nanoceramics is investigated in the following papers by Tabellion et al., focussing on SiO_2 nanoparticles, Kurinec et al., working on magnetic nickel ferrite nanoparticles and Dogan et al., who developed films from nanosized $BaTiO_3$.

References

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