

## **Report**

### **Symposium A on Carbon-based nanostructured composite films**

#### **Nanomaterials and Nanotechnology**

#### **E-MRS Spring Meeting 2008**

Carbon-based nanostructured composite (CBNC) films consisting of nanometer-sized particles embedded in a carbon-containing host matrix (hydrogen-free or hydrogenated amorphous carbon, diamond-like carbon or polymer matrix) exhibit a variety of attractive properties in solid-state physics and are promising for various applications in advanced technologies (electronics, catalysis, wear protection, data storage, optical devices and sensors). These films may possess unique physical and/or chemical properties depending on the size of embedded particles and interface effects. CBNC films can be produced by physical and chemical vapor deposition techniques, pulsed laser ablation, plasma-assisted and other hybrid techniques as well as by solution chemistry methods such as sol-gel, electrodeposition and electroless deposition. These films exhibit specific mechanical and tribological properties attractive for microelectromechanical systems (MEMS), electrical and dielectric properties suited for microelectronic devices, optical properties as selective absorber films for flat plate solar collectors, and magnetic properties required for high-density magnetic data recording. Further potential fields of use include pharmaceutical and biomedical applications.

During the four days of Symposium A, more than forty oral presentations were given, and about fifty posters shown. Invited speakers included distinguished scientists such as H. Hofsäss, M. Stüber, Ulf Jansson, T.-P. Nguyen, K.I. Schiffmann, M. Farle and G. Dennler.

While some participants knew each other already from a previous ESF exploratory workshop held in Fall 2006 in Gdansk, many new contacts between scientists working on CBNC films were established.

The programme of Monday, the first day of Symposium A, focused on recent progress in synthesis and deposition techniques of CBNC films. The opening talk by H. Hofsäss (University of Göttingen, Germany) guided the audience “beyond the sputtering limit” of advanced deposition techniques. Going beyond the sputtering limit allows modifying surfaces in a novel way. The talk by M. Stüber (Forschungszentrum Karlsruhe, Germany) compactly summarized the influence of the metal concentration on the properties of Me:C films. The contributed presentations ranged from new ideas for coating production, e.g., for free standing CBNC films, reaching higher deposition rates, or up-scaling of processes, to fundamental investigations, e.g. regarding the production of nanocrystalline carbides in a-C and a-C:H matrix characterized by various standard and sophisticated techniques. M-A-X phase materials, as carbon-containing ternary systems, can be nanostructured as nanolaminates or nanocomposites. Their synthesis and properties were instructively presented in the invited talk from U. Jansson (Uppsala University, Sweden). The nanocomposite properties of carbon nanotubes embedded in different matrixes were the content of various contributed presentations.

On Tuesday, the optical and mechanical properties of CBNC films came into the focus of attention. T.-P. Nguyen (Institut des Matériaux Jean Rouxel, Nantes, France) gave an overview on the properties of hybrid nanocomposites for optical applications. Such organic-inorganic hybride films exhibit amazing effects such as cluster-matrix interactions and benefit from an improved durability. The tribological properties of metal containing DLC coatings were addressed by K. Schiffmann (Institut für Schicht- und Oberflächentechnik,

Braunschweig, Germany). Methodologies to investigate the structural properties of these films were outlined. In addition, a number of contributed presentations demonstrated the influence of the structure of CBNC films on their mechanical properties. Due to their promising mechanical properties, metal containing DLC coatings become already today more and more important for applications as hard and protective coatings. Combining fascinating optical properties with excellent mechanical properties, nanostructured carbon based films are also highly interesting candidates for selective coatings on solar absorbers for thermal solar collectors.

The magnetic properties of CBNC films were discussed on Wednesday morning by M. Farle (University Duisburg-Essen, Germany) and by N. Jaouen (SOLEIL, Gif/Yvette, France). Both speakers highlighted possible applications of FePt nanoparticles in the area of high-density magnetic data storage.

The following sessions dealt with biomedical and biochemical applications. CBNC are highly interesting for biocompatible coatings on medical implants such as artificial joints, or stents in blood vessels. Studies focused on the tribological behaviour of such coatings, and on the ellipsometric characterisation of surfaces exposed to a biological environment. Amazing fluorescent properties of surface functionalized carbogenic quantum dots were reported. F. Schwarz (University of Augsburg, Germany) earned the Graduate Student Award for his presentation of a novel synthesis technique of antimicrobial coatings by an innovative combination of sol-gel and ion beam irradiation techniques.

The oral presentations of Thursday morning were tackling the issues of the fascinating electronic structure and the electrical properties of CBNC films. G. Dennler (Konarka GmbH, Austria) highlighted the importance of morphology in donor-acceptor composite organic solar cells. Several speakers illustrated the impact of the nature of the element incorporated in the nanocomposite film (including metal nanoparticles, onion-like carbon, diamond, amorphous boron, etc.). Characterization methods include VEELS, photoelectron and Auger spectroscopies, transport measurements, and scanning tunneling microscopy and spectroscopy. C-cage based films represent ultra low-k materials which can open new possibilities for on-chip interconnect structures. Presentations of theoretical results of wave packet dynamical simulations of electron transport through graphene nanodevices, and of the modelling of the electromagnetic response of onion-like carbon based composite films concluded the symposium by the end of Thursday afternoon.

During the two poster sessions on Tuesday and Thursday, a wide variety of topics concerning CBNC films were presented. Thanks to this occasion for a direct interaction with the authors, many inspiring discussions took place, and novel ideas for future collaborative research activities were discussed.

During a meeting of the scientific committee of Symposium A, possibilities for future collaborative research activities were discussed. The decision was made to prepare a proposal for a new ESF network on CBNC films, and the roles of the partners concerning the different subtasks were identified. All participants of this meeting showed a strong motivation to continue the exploration of the fascinating research field of CBNC films.

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