The 4th International Conference on Structural NanoComposites (NANOSTRUC2018)

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Abstract. The NANOSTRUC 2018 was held at HTW Berlin. NANOSTRUC2018 and brought together an international community of researchers in Berlin (Germany) on 23-24 May 2018. The conference was aimed for stakeholders to discuss the state-of-the-art, new research results, perspectives of future developments, and innovative applications relevant to structural materials, engineering structures, nanocomposites, modelling and simulations, and their related application areas. A sample of papers presented at the NANOSTRUC 2018 are briefly summarised.

1. Introduction

The recent developments in understanding and improved manufacturing techniques of nanoparticles have rapidly introduced engineering nanomaterials across the commercial industry. Manufacturers can now disperse nanoparticulate nanotubes, metals, layered silicates, oxides and other nanomaterials with polymers, metals and ceramics to optimize the composite’s properties. This in turn provides proprieties and performances while opening doors for new inventions. It is however still challenging to identify the specific number of commercial products using nanomaterials. The online inventory of products (Nanodatabase, http://www.nanodb.dk) claimed by manufacturers to contain nanomaterials or be based on nanotechnology currently entails over 2000 products. These products that are most products fall into “personal care” and “clothing” categories (over 300) followed by “sporting goods” and “cleaning” (over 200). Overall, the annual applications of nanomaterials are on an increase especially in engineering and medical applications.

NANOSTRUC 2018 sessions focused on Automotive & Aerospace Materials, Nanosensors, Hybrid Composites, Biomaterials and Biomedical Devices, Functional Nanocomposites and an overview of the keynote presentations are summarised below.

2. Modelling and Simulations

Numerical approaches in the study of hybrid nanofluids and their possible applications in solar energy was presented by Alina Adriana Minea (Technical University Gheorghe Asachi, Romania). Latest research in this area clearly show that the hybrid nanofluids a very promising heat transfer media. This is mainly because of the synergistic effect through which they provide promising properties of all its constituents. The hybrid nanofluids are a new sort of nanofluid that can be prepared by mixing two nanofluids, by suspending (i) different types (two or more than two) of nanoparticles in a base fluid, or by suspending (ii) hybrid (composite) nanoparticles in a base fluid.

Kambiz Kayvantash (CADLM, France) presented a key note on reduced order modelling for complex, time dependent and multi-scale modelling. The presentation covered a general purpose, innovative and simple approach in order to develop “reduced order models” of large, time dependent and CPU-consuming applications which may even involve multi-physics or multi-scale applications (such as material characterization). These models have the advantage of being re-employed in a “solver independent” environment as sub-parts or components which need not be recomputed at every cycle.
but can simply be reconstructed from existing results. The computation time is efficiently improved, and off-the-shelf models may be optimally exploited in a wide variation of scenarios, including real-time computing. It was noted that major advantage of this approach is that a reduced order model generated by any FE code or experimental test could easily be used for coupling with any other commercial FE code or existing real-time solver. Examples of applications for biomaterial modelling were provided.

3. Cellulose nanocrystals

Cellulose nanocrystals (CNCs) are considered as innovative biomaterial with large reinforcing potential and a kind of nanomaterial that can add functional properties of polymer composite materials, including enhanced barrier and mechanical properties. Preparation and characterisation of cellulose nanocrystals for bio-based polyamide reinforcement was covered by Krzysztof Pielichowski. (Cracow University of Technology, Poland) Various methods of CNCs preparation lead to materials with different structure/morphology and characteristics; as standardization protocols are at infancy this issue requires detailed description in regard to substrate sources, reaction conditions, purification routes, etc. One of the key factors is the thermal stability of CNC since it may limit the processing possibilities with other (synthetic) polymer matrices. The processing temperature of most engineering polymers is close to or exceeds the onset temperature of cellulose degradation.

Yury Shchipunov (Russian Academy of Sciences, Russia) presented the functional bionanocomposites prepared through cellulose mineralization. It follows that the alkaline earth stannates with the general formula RSnO$_3$ (R = Ba, Sr and Ca) are important material systems in view of their interesting physical properties and perovskite structures. Perovskite-type oxides have a simple and flexible structure that is easy for ionic substitution, carrier doping and oxygen non-stoichiometry, which can form a vast set of technologically important materials for a wide variety of industrial applications. The study indicated that a high optical limiting efficiency, comparable to that of graphene and its metal hybrids.

4. Fibres and their composites

As filler reinforced nanocomposite technology is progressing into its mature stage, the advantage and shortage of different solutions for structure reinforcement developed so far have become progressively clear. Fengge Gao (Nottingham Trent University, United Kingdom) explored the problems with the current filler-reinforced nanocomposite technology and their potential solutions. From the point of view of the properties of reinforcing elements, nanofillers have better strength and stiffness than traditional fibres and micro-sized fillers. Matters arise when nanofillers are integrated into matrix to form composite structure. One problem encountered in early stage of development was the restriction of filler loading. Nanofiller reinforcement is only effective in low filler content in nanocomposites. As filler loading increases, filler aggregation and poor dispersion become more and more significant resulting in rapid reduction in efficiency of reinforcement.

Theodora Krasia-Christoforou (University of Cyprus, Cyprus) focused on functional polymer-based nanocomposite fibres via electrospinning. The study explored magnetite-containing electrospun microfibres as well as the microrods with applicability in the biomedical field and in water remediation processes and catalytic electrospun polymer fibres with embedded metal and metal oxide nanoparticles that were successfully employed as effective heterogeneous catalytic supports in organic synthesis. Electrospinning can be used for the fabrication of polymer, ceramic and polymer-based nanocomposite fibres. The latter may be accomplished through the incorporation of inorganic nanoparticles within polymer fibres during electrospinning or via their anchoring onto the fibres’ surfaces by following post-modification strategies. This fact renders the technique highly attractive and competitive in biomedical, optoelectronic, environmental, sensing, catalytic and energy-related applications.

Raquel Verdejo (CSIC, Spain) presented on the carbon nanoparticles for epoxy hierarchical composites. Compared to CNTs, graphene has advantages such as lower cost, higher surface area and a greater ease of processing. The study reported the effect of carbon nanoparticles, both CNTs and graphene, in epoxy
systems to understand their effects on the curing, morphology and properties. It also covered the fabrication and characterization of hierarchical composites by inclusion of graphene to conventional continuous carbon fibre reinforced epoxy composites by vacuum-assisted resin transfer moulding and its self-healing ability.

5. Sensory Materials

The electrically conductive composites with polymeric matrices are usually designed by mixing insulating polymeric matrix with electroconductive fillers. Recently also several new nanofillers have been used, such as carbon nanotubes, graphene, metal nanoparticles, etc. Smart electrically conductive polymeric nanocomposites talk was presented by Mária Omastová (Polymer Institute, Slovak Academy of Sciences). She explored the important challenge in the production of electrically conductive polymeric composites particularly on creating conductive paths through non-conducting polymeric matrix. The study also covered fabrication of nanocomposites using electrospun polycaprolactone and styrene butadiene rubber (SBR) as the polymeric matrix and two types of carbon nanofillers, carbon black (CB) and CNT. The ability of prepared composites to act as sensors for three organic gases, toluene, THF, and n-hexane, by the changing of their electrical properties was reported.

Manolis Hourdakis and Androula Nassiopoulou (The Institute of Nanoscience and Nanotechnology (INN) of NCSR “Demokritos”) presented on nanosilicon as a material for sensors and thermoelectrics while Alois Lugstein (Vienna University of Technology, Austria) presented on the synthesis and applications of monolithic quasi 1D metal-semiconductor nanowire heterostructures. A novel synthesis approach for semiconductor-metal NW heterostructures that employs millisecond flash lamp annealing (FLA) along with several standard techniques of semiconductor manufacturing like sputtering and plasma enhanced chemical deposition (PE-CVD). The Lugstein’s research group has recently demonstrated the formation of axial Al-Ge-Al NW heterostructures with abrupt interfaces and monocrystalline aluminum (Al) leads by using a thermally initiated exchange reaction. This enables the formation of an in line contacted Ge quantum dot without requiring precise lithographic alignment of the contacts, which is one of the most challenging issues of fabricating quantum dot-based devices.

6. Optical Materials

The production of diffraction gratings makes use of typical micro- and nanotechnology processes including thin film deposition, ion etching, lithography and the corresponding analytics, mainly atomic force microscopy. Marcus Lörgen (HTW University of Applied Sciences, Berlin, Germany) presented a key note on optical grating technology. The presentation examined the production process that consists of over 20 steps grouped into the masking step, the texturing step and the finishing step including measuring processes for quality control. Typical line structures for the diffraction gratings have periods of 600 nm to 3 µm with extreme values of down to 250 nm. The height of laminar line profiles is in the range of 5 nm(236,567),(360,581) to 50 nm. Angles for blazed gratings are typically specified between 0.3° to 2° with respect to the optical surface.

Another presentation on optical materials was by Radhakrishna Prabhu (Robert Gordon University, Aberdeen) who presented on the structural, morphological and optical properties of BaSnO₃ films prepared by pulsed laser ablation. Surface modification of carbon nanoparticles by plasma polymerization of propylene was studied aiming to enhance affinity to produce polymer nanocomposites with high thermal conductivity. For this purpose, carbon nanofibers, graphene platelets and their mixtures.

The role of the acetalization degree on the dynamical mechanical properties of polyvinylbutyral nanocomposites was the focus of the presentation by Sergio Pezzin (State University of Santa Catarina, Brazil). This work described the preparation of polyvinylbutyral (PVB) nanocomposites reinforced with pristine’ and oxidized carbon nanotubes, graphene oxide and graphene nanoplatelets, via 'in situ' polymerization, at concentrations varying from 0.1 to 2.5 wt%. The results showed that the ‘in situ’ polymerization method can improve the dispersion and final properties of the nanocomposite only if
the nanoparticles are able to form relevant interfacial interactions during the PVB synthesis process. In addition, it was verified that the presence of nanoreinforcements altered the degree of acetalization of PVB, which also contributes to influence the final properties of the nanocomposites.

Acknowledgments

We would like to acknowledge the hard work, professional skills and efficiency of the team, which ensured the general organisation, the NANOSTRUC 2018 Scientific and Organising Committees, Session Chairs and all assistants. We are high indebted to colleagues at HTW University of Applied Sciences, Berlin, Germany for a hosting the conference. We would also like to acknowledge support from our Media partners – Wiley, The Minerals, Metals & Materials Society (TMS) and Journal of Materials (JOM); Fibers Journal and Frontiers in Materials Journal. We are also grateful for laboratory visits to Helmholtz-Zentrum Berlin facilities and Fraunhofer IZM (The Fraunhofer Institute for Reliability and Microintegration.