The 3rd international conference on structural nano composites (NANOSTRUC2016).

NJUGUNA, J.

2017

3rd International Conference on Structural Nano Composites (NANOSTRUC2016)

IOP Conf. Series: Materials Science and Engineering **195** (2017) 011001 doi:10.1088/1757-899X/195/1/011001

The 3rd International Conference on Structural Nano Composites (NANOSTRUC2016)

J Njuguna[1*]

[1] Centre for Advanced Engineering Materials, School of Engineering, Robert Gordon University, Aberdeen, AB10 7GJ, United Kingdom

E-mail: j.njuguna@rgu.ac.uk

Abstract. The Robert Gordon University, Aberdeen hosted The NANOSTRUC 2016 in Aberdeen (Scotland, United Kingdom). The conference focused on 'Nanoscience and Nanotechnologies – Recent Advances towards Nanoproducts and Applications'. It promoted activities in various areas on materials and structures by providing a forum for exchange of ideas, presentation of technical achievements and discussion of future directions. The conference benefitted from keynote lectures focused on topical issues in nanosciences and nanotechnology. The key sessions were on Application of Nanomaterials and Nanocomposites, Functional Nanocomposites, Graphene and Carbon-based Nanocomposites, Metallic and Metals Oxide Nanocomposites, Sustainability - Nanosafety & Environment, Toughness of Polymer Nanocomposites, Biocomposites and Nanofibres and on Fibre Reinforced Composites. A sample of papers presented at the NANOSTRUC 2016 are briefly summarised in this Issue

1. Introduction

Large quantity of nanomaterials such as carbon nanotubes, nanofibers, polyhedral oligomeric silsesquioxane (POSS), graphene, SiO_2 and layered silicates such as montmorillonite is presently available. This is made possible due to the establishment of well-developed manufacturing technologies such as chemical vapor deposition method, ball milling and electrospinning. The global nanotechnology market is expected to reach $90.5 billion by 2021 from $39.2 billion in 2016 at a compound annual growth rate (CAGR) of 18.2%, from 2016 to 2021 [1]. Growing demand for nanocomposites in industrial applications such as in transport sector, increased application of nanocomposites in building and construction, high volume consumption in electronics and semiconductors are some of the major factors that have been driving the market.

A sample of papers presented at the NANOSTRUC 2016 are briefly summarised in this Issue. The 3rd International Conference on Structural Nano Composites (NANOSTRUC2016) followed on previous conferences held in Madrid in Spain [2,3] and in Bedfordshire in the UK [4,5]. To start with, the conference benefited from Dr Clare Hoskins Keynote Lecture on 'Temperature Controlled Theranostics for Cancer Therapy' [6] highlighting the importance of nanomaterials and nanotechnology in the frontline against cancer. These cytotoxicity studies combined with cellular uptake studies showed the formulations to be significantly more effective compared with gemcitabine thanks to utilisation of hybrid nanoparticles composed of an iron oxide core surrounded by a rigid gold shell.

2. Sensors and Nanoelectronics

Dr Radhakrishna Prabhu Keynote talk covered 'Structural and nonlinear optical property of $BaSnO_3$ nanopowder prepared by solid-state ceramic method' concentrating on $BaSnO_3$ [7]. This material has a cubic perovskite-type oxide that behaves as an n-type semiconductor with a wide band gap of 3.4 eV and remains stable at temperatures up to 1000°C. It follows on that barium stannate is used in optical

applications, in capacitors and ceramic boundary layers, and as a promising material to produce gas phase sensors for the detection of carbon monoxide and carbon dioxide. On the same topic on optical properties, Mukonza et al [8] investigated the effects of increasing reusability iterations on morphological, optical and crystallinity properties of trivalent-doped TiO_2/CNT photocatalysts as an alternative water treatment method. They also investigated the improvement of photocatalytic efficiency of TiO_2 during the photo-mineralisation of brilliant black (BN) bis-azo dye pollutant in aqueous solution [8]. The researchers improved the visible light activity of TiO_2 photocatalyst semiconductor through co-doping of fluorine (F) and trivalent samarium ions (Sm^{3+}) into a TiO_2 matrix using a modified sol-gel synthesis method. Further, Johny et al [9] conducted computational studies on drawback of commercially available photonic crystal fibres (PCF) which is their limited operating wavelengths, which is mostly in the infrared (IR) spectral band. Theoretical study revealed that a nanostructured PCF experiences reduced confinement losses and improved mode field diameter. On a different note, Yu et al [10] reported on the development asphaltenes as new objects for nanoelectronics. Asphaltenes are complex materials that exist in crude oil, bitumen and high-boiling hydrocarbons distillates. They noted that the paramagnetic phase of asphaltenes is organic amorphous wide band gap semiconductor.

3. Water-Nanomaterials Research

Water research extensively utilise nanomaterials for the treatment, remediation, and pollution prevention. The focus of the lecture will to provide an overview of the nanoscale materials for wastewater chemistry as futuristic materials. Prof. Ajay Mishra Keynote Lecture covered this topic on a talk titled 'Nanoscale Sovereignty in Waste Water Chemistry' [11]. It specifically focused on nanomaterials in water research for the treatment, remediation, and pollution prevention. Masheane et al [12] studied chitosan-alumina/functionalised multiwalled carbon nanotube (f-MWCNT) nanocomposite beads to developed and investigate the reduction of various physico-chemical parameters for drinking water. The researchers reported that the chitosan nanocomposite beads offer a promising alternative material for reduction and removal of various physico-chemical parameters for production portable water. In the same field, Prof Sabelo Mhlanga's Keynote presentation focused on 'Chitosan-Based Nanocomposite Beads for Drinking Water Production' [12]. His work covered the chitosan-alumina/functionalised multiwalled carbon nanotube (f-MWCNT) nanocomposite beads that were developed and investigated for the reduction of various physicochemical parameters from water samples collected from open wells used for drinking purposes by a rural community in South Africa.

4. Hybrid Composites

Lab-scale preparation of polymer nanocomposites with layered silicates developed in the last two decades and the most important factors that contribute to the structure of polymer-based clay nanocomposites identified. However, most of the experiments are laboratory-scale and the question how to up-scale the process toward industrial production scale still remains not fully answered. Another issue that requires more research attention is recycling of polymer nanocomposites. Among different methods, pyrolysis seems to be an interesting alternative. This study was the focus of a Keynote Lecture titled 'Polymer Nanocomposites with Layered Silicates - Up- Scaling of Production and Recycling' by Prof. Pielichowski [13]. His team of researchers have also developed a novel method of polypropylene/montmorillonite nanocomposites recycling by pyrolysis to produce pyrolysed montmorillonite (MMT) for the preparation of polymer composites.

An interesting paper by Almansoori et al [14] reported on the fabrication and characterization of plasma-treated organoclay/Nylon 12 nanocomposite carried out with the aim of achieving better dispersion of clay platelets on the Nylon 12 particle surface. They used the air-plasma etching to enhance the compatibility between clays and polymers to ensure a uniform clay dispersion in composite powders. Meanwhile, Starost et al [15] studied the effect on nanoparticle emissions due to drilling on

polypropylene (PP) reinforced with 20% talc, 5% montmorillonite and 5% wollastonite (WO). The study is the first to explore the nanoparticle release from WO and talc reinforced composites and compares the results to previously researched MMT in the literature. The size distribution data displayed a substantial percentage of the particles released from the PP, PP/WO and PP/MMT samples to be between 5-20 nm, whereas the PP/talc sample emitted larger particle diameters. The study noted that the high usage of nanomaterials and nanotechnology along with the environmental impact of certain materials used in nanocomposites manufacturing need due considerations.

Hierarchically structured hybrid composites are ideal engineered materials to carry loads and stresses due to their high in-plane specific mechanical properties. Watson et al [16] reported on the tensile and flexural properties of hybrid graphene oxide /epoxy carbon fibre reinforced composites (GO/EP/CFRC). It was observed that the tensile and flexural strength of the EP/CF decreased with the addition of GO but increased with GO weight concentration in the nanocomposites studied. Mukherje et al. [17] reported on a new invention that comprises a method of making a transparent glass laminated nanocomposite product. The product contains a bidirectionally oriented E-Glass fabric an essentially bidirectional yarn woven fabrics is stretched bidirectionally by specially fabricated steel frame associated with both co- and counter-rotating device.

5. Green Composites

Dr Youssef Habibi delivered another interesting Keynote lecture titled 'Nanocelluloses: Emerging Biobased Building Blocks for Nanostructured Materials' [18]. It also provided few examples related to nanocellulose processing using various techniques to access useful nanostructured materials for different applications. This interesting lecture. Sustainable Bioplastics from Microbes and Waste by Dr Christine Edward reported on strategies for exploiting microbes grown on waste substrates for production of polyhydroxalkanoates (PHAs), a group of polyesters produced mainly as storage compounds in bacteria where biosynthesis triggered by nutrient limitation and stress [19].

A study by Habibullah et al [20] investigated on the mechanism of self-healing and cavity filling in case of steel inoculated with seashell powder. It follows that the seashells such as the abalones use a protein mortar for reinforcement. The researchers identified the protein and mechanism how the protein mortar stretches itself into ligaments that bridge the gap, with the help of microscopy. Sharipov and Bakhtizin [21] work developed a method for estimation of quantitative parameter of immobilization of oligonucleotides is reliant on on their degree of aggregation depending on the fixation conditions on the surface of mica. The study reports on aggregation of oligonucleotides immobilized on mica surface morphology and associated physic-chemical features. Another keynote lecture by Prof Kalia Susheel titled 'Biocomposites and Their Applications' proposed that the biografting of natural organic molecules on natural fibres is one of the best environmentally friendly methods [22]. Applications of such green composite materials include biomedical applications, structural applications, consumer products, food packaging, transportation, and textile, sports & leisure industry**.**

6. Oil and Gas Applications

The Keynote Talk on 'Nanotechnology Needs in Oil and Gas Industry Applications' by Prof Babs Oyeneyin covered the potential for nanotechnology application across the supply chain of the oil industry operations from exploration through to well construction and reservoir management/monitoring to production flow assurance [23]. He delivered show case examples of key areas of potential applications. The talk noted that the industry key challenge is to reduce cost and be more operationally efficient to guarantee the oil/gas flow assurance and that the nanotechnology is one of the key technologies required to achieve these objectives. On the same topic, Siddique et al [24] review study provided an overview on the basic concepts of drilling fluids and their functions, sources and

characterisation of drilling wastes, and highlights some environmentally significant elements including different minerals present in drilling waste stream. The study is part of an on-going work at Robert Gordon University, Aberdeen, to convert the drilling fluid waste into polymer additives for oil and gas nanocomposites applications.

7. Best Student Poster Awards

Wiley and Nanoscale Horizons, Royal Society of Chemistry sponsored the young researchers' awards for NANOSTRUC 2016. The poster titled 'The Effect of Talc, Montmorillonite (MMT) and Wollastonite (WO) on Nanoparticle Release due to Mechanical Drilling from Polypropylene (PP) Composites' [15] by Kristof Starost won the Best Poster Award supported by the Nanoscale Horizons, Royal Society of Chemistry. The study provided new insight and a better understanding on how various fillers effect the release of nanoparticles during machining of composites to evaluate and quantify the full exposure risks associated to nanorelease and nanoparticle at this stage of manufacturing process. The second best poster award went to Ekaterina Mitrofanova poster on her work on 'Dimensional Dependent Electronic Properties in Tetragonal Iron Chalcogenides' [25]. The study investigated a change of electronic structure during the transition from bulk material to two-dimensional one for iron chalcogenides (FeSe, FeTe, for up to 15 layers and bulk material) with ab initio calculations. Nanoscale Horizons, Royal Society of Chemistry, also sponsored the Second Poster Award.

Karsta Heinze and Chinere Okolo both received the Third Poster Prize Award sponsored by Wiley. Heinze work focused on 'The Wheat Grain as a Cemented Granular Material: Nanoscale Investigation of its Mechanical Properties' [26]. She applied a multiscale experimental and modelling approach to investigate the nanomechanical properties of the composing polymers and the way they influence grain fragmentation, with the aim of linking nanomechanics of specific grain samples to their milling behaviour, which was determined with a laboratory mill nanoscale and macroscale mechanical properties. On the other hand, Okolo studied 'Dynamic Mechanical Analyses for Molecular Level Engineering of Advanced Subsea Polymers' [27]. The poster presented a study on dynamic mechanical analysis (DMA) characterization of engineering polymer with focus on its mechanical behaviour and thermal stability at elevated temperatures. She noted that challenging subsea field developments in ultra-deepwaters has significantly pushed the need for reliable engineering materials and products for high pressure and high temperature applications, hence the need for in-depth knowhow on nanoscale mechanics.

Acknowledgments
We would like to acknowledge the hard work, professional skills and efficiency of the team, which ensured the general organisation, in particular the NANOSTRUC 2016 Scientific and Organising Committees, Session Chairs and all assistants. We would also like to acknowledge support from our industrial and Media partners – Wiley, BREC and Nanoscale Horizons, Royal Society of Chemistry; UK's Knowledge Transfer Network- Nanotechnology (UK); Innovation (Greece); The Minerals, Metals & Materials Society (TMS); Nafigate; VisitAberdeen; LIFE 11 programmes through SIRENA project. Financial funding from UK-India Research Initiative (Project No. DST/INK/UK/P-108/2014) on graphene hybrid composites is acknowledged. Special thanks to our host Robert Gordon University and academic partners including Consejo Superior de Investigaciones Científicas (CSIC) and University of South Africa.

References
[1] Market Research Reports, NAN031G, 2016.
[2] Njuguna, J., and R. Verdejo, 2014, *IOP Conf. Ser.: Mater. Sci. Eng*. **64**, No. 1. IOP Publishing.
[3] Njuguna, J, Verdejo R and Starost K, 2014, NANOSTRUC 2014Book of Abstracts.

[4] Njuguna J and Sachse S, 2012 NANOSTRUC 2012 Book of Abstracts.
[5] Njuguna J 2012 *IOP Conf. Ser.: Mater. Sci. Eng.* **40** 01100, IOP Publishing, 2012.
[6] Hoskins C, 2016, NANOSTRUC 2016 Book of Abstracts, pg 16.
[7] John J, Pillai VPM, Thomas AR, Philip R and Prabhu R, 2016, NANOSTRUC Book of Abstracts, pg 27.
[8] Mukonza SS, Nxumalo EN, Mamba BB and Mishra AK, 2017, *IOP Conf. Ser.: Mater. Sci. Eng*. **XX**, No. XX. IOP Publishing.
[9] Johny J, Fung WK and Prabhu R, 2017, *IOP Conf. Ser.: Mater. Sci. Eng*. **XX**, No. XX. IOP Publishing.
[10] Yu DM, Bakhtizin RZ, Petrov AM, Shutkova SV, Dolomatova MM, Hayrudinov IR, 2017, *IOP Conf. Ser.: Mater. Sci. Eng*. **XX**, No. XX. IOP Publishing.
[11] Mishra AK, 2016, NANOSTRUC Book of Abstracts, pg 17.
[12] Masheane ML, Nthunya LN, Sambaza SS, Malinga SP, Nxumalo EN, Mamba BB and Mhlanga SD, 2017, *IOP Conf. Ser.: Mater. Sci. Eng*. **XX**, No. XX. IOP Publishing.
[13] Pielichowski K, Majka T, 2016, NANOSTRUC Book of Abstracts, pg 30.
[14] Almansoori A, Seabright R, Majewski C and Rodenburg C, 2016, NANOSTRUC Book of Abstracts, pg 51.
[15] Starost K, Frijns E, van Laer J, Faisal N, Egizabal A, Elizextea A, Nelissen I, Blazquez M and Njuguna, , 2017, *IOP Conf. Ser.: Mater. Sci. Eng*. **XX**, No. XX. IOP Publishing.
[16] Watson G, Starost K, Bari P, Faisal N, Mishra S and Njuguna J, 2017, *IOP Conf. Ser.: Mater. Sci. Eng*. **XX**, No. XX. IOP Publishing.
[17] Mukherji A, Tarapure ND, Wakure GN, 2017, *IOP Conf. Ser.: Mater. Sci. Eng*. **XX**, No. XX. IOP Publishing.
[18] Habibi Y, 2016, NANOSTRUC Book of Abstracts, pg 31.
[19] Edwards C and Lawton L, 2016, NANOSTRUC Book of Abstracts, pg 44.
[20] Habibullah P, Siddiqui S, Siddiqi SA, 2017, *IOP Conf. Ser.: Mater. Sci. Eng*. **XX**, No. XX. IOP Publishing.
[21] Sharipov TI and Bakhtizin RZ, 2017, *IOP Conf. Ser.: Mater. Sci. Eng*. **XX**, No. XX. IOP Publishing.
[22] Susheel K, 2016, NANOSTRUC Book of Abstracts, pg 56.
[23] Oyeneyin B, 2016, NANOSTRUC Book of Abstracts, pg 53.
[24] Siddique S, Yates K and Njuguna J, *IOP Conf. Ser.: Mater. Sci. Eng*. **XX**, No. XX. IOP Publishing.
[25] Mitrofanova Eand Mitrofanov A, 2016, NANOSTRUC Book of Abstracts, pg 85.
[26] Heinze K, Delenne JY, George M and Lullien-Pellerin V, 2016, NANOSTRUC Book of Abstracts, pg 57.
[27] Okolo C, Wood C and Inam F, 2016, NANOSTRUC Book of Abstracts, pg 91.