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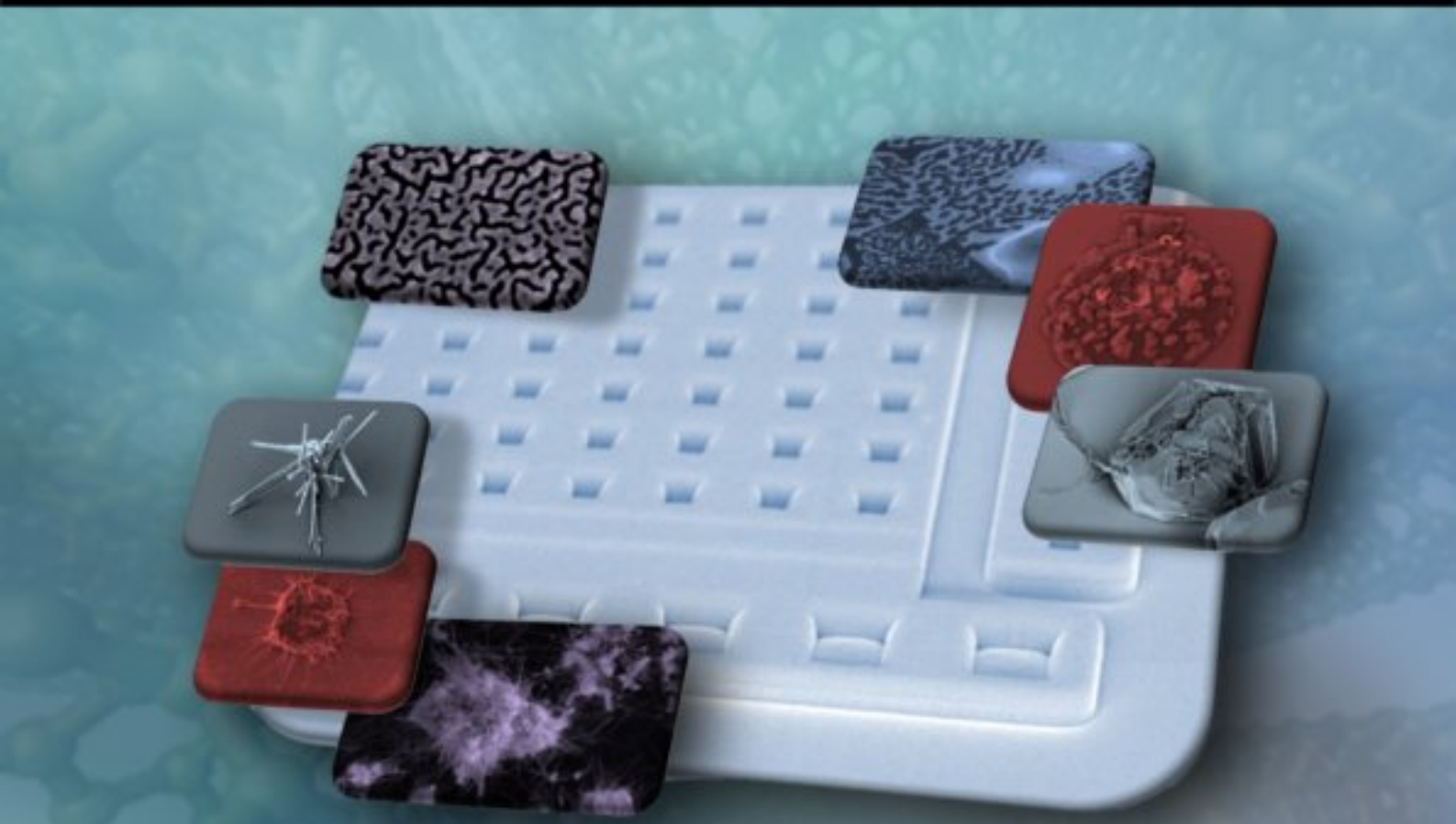

Nanomaterials and their Composites: from Fabrication to Applications

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Contents

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Research Articles

Authors are encouraged to submit article in MS Word (doc) and Acrobat (pdf) formats by e-mail: editor@sensorsportal.com
Please visit journal's webpage with preparation instructions: http://www.sensorsportal.com/HTML/DIGEST/Submition.htm

The 3rd COINAPO Topical Meeting

Composites of Inorganic Nanotubes & Polymers

"Nanomaterials & their composites: from fabrication to applications"

March 2 - 3, 2011

Sestriere, Italy

COINAPO

Is an activity in the framework of
European Cooperation in the field of Scientific & Technical Research **(COST)**.

Inorganic nanotubes are an interesting alternative to carbon nanotubes, showing advantages such as easy synthetic access, good uniformity & solubility, & predefined electrical conductivity depending on the composition of the starting material. They are therefore very promising candidates as fillers for polymer composites with enhanced thermal, mechanical, & electrical properties.

TOPICS

- Synthesis of nanotube materials
- Functionalization of the nanotubes
- Dispersion & alignment of nanotubes in polymer networks
- Characterization of composite materials
- Theory on the fundamentals of composites
- Applications:

→ Self-powered devices
→ Automotive & aeronautics
→ Optical communication networks
→ Organic solar cells
→ Composites for heat dissipation, electromagnetic interference shielding & electrostatic dissipation
→ Composites for wear protection
→ Large area flexible multifunctional sensors
→ Smart sensors

LOCATION

Ròseo Hotels Sestriere****
Via Sauze 3/B ,10058, Sestriere, Italy

CONFERENCE FEE

COINAPO Conference has no fee: it is free of charge.

PAPERS

Will be published in the
Sensors&Transducers Journal *e*-journal of
International Frequency Sensor Association.

IVITED SPEAKERS

Jinhui Song
Center for Nanostructure, Georgia Institute of Technology, Atlanta (USA)

Gianfranco Innocenti
New Materials Scouting and Nanomaterials , Centro Ricerche FIAT, Orbassano (Italy)

Wolfgang Tremel
Institute of Inorganic Chemistry and Analytical Chemistry, Johannes Gutenberg Universität Mainz, Mainz (Germany)

Adreano Zecchina
Center of Excellence "Nanostructured Interfaces and Surfaces, University of Turin, Turin (Italy)

Thibault Villette
e-Xstream engineering SaRL, Bascharage (Luxembourg)

Marco Pizzi
Eltek Group, Casale (Italy)

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Selected papers of the 3rd Topical Meeting on Composites of Inorganic Nanotubes & Polymers (COINAPO) "Nanomaterials & their Composites: from Fabrication to Applications", 2-3 March 2011, Sestriere, Italy

Preface

Ilze Aulika, Katarzyna Bejtka, Irena Drevenšek-Olenik

Received: 15 June 2011 /Accepted: 18 July 2011 /Published: 31 October 2011

This issue contains a selection of papers presented at the 3rd Topical Meeting on Composites of Inorganic Nanotubes and Polymers (COINAPO), which was held at the Roseo Hotel in Sestriere (Italy) from March 3 to March 4, 2011. The meeting was organized by the Center for Space Human Robotics (IIT@PoliTO) at Italian Institute of Technology (IIT) in Turin (Italy) and was following immediately after the PIEZO 2011 conference, organized by the Centro Ricerca FIAT. This enabled easy participation of researchers to both events that had several overlapping topics. Both meetings shared one invited speaker - Dr. Jinhui Song from Georgia Institute of Technology (USA).

The 3rd COINAPO Topical Meeting was attended by 40 researchers, including 7 invited speakers (3 from universities and 4 from industry). It brought together researchers from 17 European countries, Israel and USA. The presentations were divided into 6 oral sessions that included 7 invited talks presented by distinguished experts in their fields and 22 contributed talks. The technical sessions encompassed many developing and challenging topics, which included synthesis and functionalization of inorganic (piezoelectrics and chalcogenides) nanotube materials, dispersion and alignment of nanotubes in polymer networks, new alternative characterization methods of composite materials and applications. The large number of invited speakers gave significant insight to the topics of the conference, especially related to fabrication, characterization and applications of composites. Several invited speakers were representing industry, including automotive (FIAT), automotive and household (ELTEK), and producers of high resolution scanning electron microscopy (Carl ZEISS) and transmission electron microscopy (FEI). The conference was accompanied by a commercial exhibition of AFM instrumentation of the NT-MDT company – a leading manufacturer offering variety of nanotechnology instrumentation for different fields of research.

COINAPO is also an abbreviation for the European Cooperation in Science and Technology (COST) Action MP0902 entitled “Composites of Inorganic Nanotubes and Polymers”. COST is the longest running and widest European intergovernmental network for cooperation in research established by a Ministerial Conference of 19 European States in 1971. The goal of the COINAPO is to coordinate interdisciplinary research efforts across Europe needed to gain knowledge on fundamental features of inorganic nanotube-polymer composites and create widespread links needed for application and commercialization of this kind of composite media by European industry. Nanotubes made of

inorganic materials are an interesting alternative to carbon nanotubes, showing advantages such as e.g. easy synthetic access, good uniformity and solubility, and predefined electrical conductivity depending on the composition of the starting material. They are therefore very promising candidates as fillers for polymer composites with enhanced thermal, mechanical, and electrical properties. Target applications for this kind of composites are materials for heat management, electrostatic dissipaters, wear protection materials, photovoltaic elements, etc. Collaborative efforts are needed on this rapidly emerging field to create a basis for a highly interdisciplinary research network focused on development and exploration of inorganic nanotube-polymer composites. COINAPO started with its activities in November 2009 and at the moment links together scientists from 24 COST countries and Ukraine as the near neighbour country. About 50 research groups are contributing to the "COINAPO activities".

This issue presents the first results of collaborative research performed within the COINAPO, merging together the knowledge of scientific groups on (i) synthesis and characterization of nanotube materials with the groups that have experience in (ii) fabrication of polymer composites with carbon nanotubes (CNTs) and/or other additives and their characterization. The collected papers cover different fields starting from synthesis and characterization of composites, and concluding with the results more dedicated to applications. For example, Zak *et al.* reports the new process of large scale synthesis (50-100 g/batch) of a pure phase of multiwall WS_2 nanotubes. In view of their excellent mechanical properties and semiconducting characteristics, large number of applications could be anticipated for such nanotubes, especially in reinforcing variety of nanocomposites and for use in sensors, actuators, etc.

The paper of Cauda *et al.* represents preparation and characterization of ferroelectric polymeric nanowires (poly(vinylidene fluoride) - PVDF) through hard-templating strategy. The Curie temperature tests show an increase towards the higher temperatures for the PVDF nanowires with respect to the bulk PVDF material, thus revealing the importance of confined crystallization into mono-dimensional structures.

Milavec *et al.* demonstated that switching voltage of the polymer - liquid crystal composites with addition of 0.1 wt% $Mo_6S_4I_6$ nanotubes is considerably lowered with respect to the switching voltage of the analogous structures without the nanotubes. The addition of nanotubes causes a decrease of the threshold voltage and also improves the switching speed upon modification of an external voltage.

Di Luccio *et al.* studied the effect of incorporation of inorganic fullerene like nanoparticles and WS_2 nanotubes into device structures for organic electronics applications. Poly-3(hexylthiophene) has been used along with the WS_2 nanoparticles as an active layer for the solution-processable material in the OLED structure of the type ITO/WS_2/P3HT/LiF-Al. The investigation was focused on the electrical effect of the WS_2 layer and on obtaining information on its energy levels.

The new approach of the studies of composites is presented by Burducea *et al*, suggesting the use of nuclear methods for characterasation of nanomaterials: Positron Annihilation Spectroscopy (PAS), Nuclear Reaction Analysis (NRA) and Rutherford Backscattering Spectrometry (RBS). PAS investigation is demonstrated on polymer nanofibers providing information on vacancy defects, RBS was applied on InN thin films providing information regarding the thickness and the stoichiometry of the films. Preliminary NRA results show the possibility of detecting and measuring the hydrogen content in CNW.

Taschin *et al*. report on the use of transient-grating based time-resolved laser spectroscopy technique (TG) for investigations of thermo-elastic response of the composites. A new dynamic phenomenon producing unusual photo-elastic and photo-thermal response was found in polyurea elastomer mixed with inorganic nanotubes (MoS_2) or nanowires ($Mo_6S_2I_8$).

The study of Zohar *et al.* is dedicated to the investigation of the effect of WS_2 nanotubes on the mechanical, thermal, adhesion and tribological properties of epoxy based nanocomposites: it is shown that addition of nanotubes significantly improves all these properties, which makes inorganic nanotubes-polymer composites very promising application in different mechanical devices.

The temperature dependence of ultrasonic velocity and attenuation in an elastomeric material doped with MoS_2 nanotubes were also studied. These results are presented in the paper of Samulionis *et al*. The observed increase of the low temperature ultrasonic velocity in polymer with nanotubes is in good agreement with an increased value of the elastic modulus found by other research groups.

The dynamic mechanical analysis (DMA) and thermomechanical analysis (TMA) measurements are presented in the work of Fuith *et al.* Also this group had studied polyurea elastomer nanocomposites based on MoS_2 nanotubes and $Mo_6S_2I_8$ nanowires. The addition of a small amount of nanoparticles (<1 wt %) leads to the increase of the glass transition temperature and the Young´s modulus of up to 15% in the whole measured temperature range.

The selection of the papers presented in this volume reflects the multidisciplinary and multinational nature of the COINAPO network.

We would like to thank to all colleagues and students of the Center for Space Human Robotics (IIT@PoliTO) for their support in organization of the conference. We are especially indebted to Alessandro Zanella from Centro Ricerca FIAT, Dr. Valentina Cauda and Dr. Gabriele Ballero from IIT, Prof. Pierluigi Civera and Prof. Danilo Demarchi from Politecnicho di Torino, for their invaluable help in organizing the conference. Our acknowledgements also go to our sponsors – European Cooperation in Science and Technology (COST), International Frequency Sensor Association, and Associazione Tecnica dell'Automobile and Italian Institute of Technology for their financial support that has made the 3rd Topical Meeting of COINAPO possible. Finally, we express our gratitude to the invited speakers and to all coauthors of their contributions for the success of the conference. We are also grateful to the staff of International Frequency Sensor Association, for their careful attention to the preparation of this issue, and to referees of this proceeding, for their assistance. The series of COINAPO meetings will continue to be held in the future, reflecting the progress in the field of inorganic nanotubes – polymer composites, while maintaining the traditions of past meetings.

All papers published in this volume of Sensors & Transducers Journal, Vol.12, Special Issue, have been peer reviewed through processes administered by the proceedings Editors. Reviews were conducted by expert referees to the professional and scientific standards expected of a proceedings journal published by International Frequency Sensor Association (IFSA) Publishing.

Sensors & Transducers Journal

Guide for Contributors

Aims and Scope

Sensors & Transducers Journal (ISSN 1726-5479) provides an advanced forum for the science and technology of physical, chemical sensors and biosensors. It publishes state-of-the-art reviews, regular research and application specific papers, short notes, letters to Editor and sensors related books reviews as well as academic, practical and commercial information of interest to its readership. Because of it is a peer reviewed international journal, papers rapidly published in *Sensors & Transducers Journal* will receive a very high publicity. The journal is published monthly as twelve issues per year by International Frequency Sensor Association (IFSA). In additional, some special sponsored and conference issues published annually. *Sensors & Transducers Journal* is indexed and abstracted very quickly by Chemical Abstracts, IndexCopernicus Journals Master List, Open J-Gate, Google Scholar, etc. Since 2011 the journal is covered and indexed (including a Scopus, Embase, Engineering Village and Reaxys) in Elsevier products.

Topics Covered

Contributions are invited on all aspects of research, development and application of the science and technology of sensors, transducers and sensor instrumentations. Topics include, but are not restricted to:

- Physical, chemical and biosensors;
- Digital, frequency, period, duty-cycle, time interval, PWM, pulse number output sensors and transducers;
- Theory, principles, effects, design, standardization and modeling;
- Smart sensors and systems;
- Sensor instrumentation;
- Virtual instruments;
- Sensors interfaces, buses and networks;
- Signal processing;
- Frequency (period, duty-cycle)-to-digital converters, ADC;
- Technologies and materials;
- Nanosensors;
- Microsystems;
- Applications.

Submission of papers

Articles should be written in English. Authors are invited to submit by e-mail editor@sensorsportal.com 8-14 pages article (including abstract, illustrations (color or grayscale), photos and references) in both: MS Word (doc) and Acrobat (pdf) formats. Detailed preparation instructions, paper example and template of manuscript are available from the journal's webpage: http://www.sensorsportal.com/HTML/DIGEST/Submition.htm Authors must follow the instructions strictly when submitting their manuscripts.

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