Proceedings of the International School and Workshop 'Nanoscience and Nanotechnology 2006' (University of Rome Tor Vergata and the Catholic University of Rome, 6–9 November 2006)

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PREFACE

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A strong interest in assessing the current state of the art of the fast growing fields of nanoscience and nanotechnology, as well as the need of stimulating research collaboration, prompted Dr S Bellucci, Professor A Bergamaschi and Professor E Bergamaschi to organize the International School and Workshop 'Nanoscience and Nanotechnology (n&n 2006)', November 6–9, 2006, under the patronage of the INFN (Italian Institute for Nuclear Physics), the Università di Roma 'Tor Vergata' and the Catholic University of Rome, with generous sponsorship by 3M, 2M Strumenti, Physik Instrumente, RS. The aims of this event were manifold:

- fostering the concrete planning of future devices based on innovative (nano)materials, involving both industrial entities and public research institutes
- allowing the presentation by sponsoring firms of their instrumentation and success stories, based on current use by significant customers
- lending an opportunity for preparing and presenting joint projects, involving both industry and public research, see eg the EU Framework Programs
- exploring the possibility of integrating nanodevices from their concepts into system projects.

The conference gathered at Villa Mondragone in Monteporzio Catone, Italy, leading experts in research and innovative technologies in bio-medical, aerospace, optoelectronics, instrumentation, coming both from the academic research and the industrial areas, as well as national security and military defence experts offering the opportunity for the exchange of knowledge and the collaboration among the different stakeholders in the field of nanotechnology.

A special poster and equipment session was devoted to the exhibit by various firms of their institutional activities in selected areas of application where nanoscience can have a deep impact. There has been also the possibility for sample testing by the participants. Tutorial lectures were delivered at the School, addressing general and basic questions about nanotechnology, such as what they are, how does one go about them, what purposes can they serve. In tutorial sessions the nature of nanotechnology, the instruments of current use in its characterizations and the possible applicative uses have been described at an introductory level.

The conference covered a large range of topics of current interest in nanoscience and nanotechnology, including aerospace, defence, national security, biology, medicine, electronics. The program for the first two sessions devoted to Aerospace, Defence and National Security has been setup in collaboration with the University of Rome 'La Sapienza', Department of Aerospace and Astronautics Engineering.

The opening address was delivered by Giancarlo Grasso, Central Technical Director of the Finmeccanica Group, in representation of the President, Pier Francesco Guarguaglini while the first tutorial lecture was given by Milind Pimprikar, CANEUS' founder and chairman,

who will illustrate its mission, i.e. 'to provide a platform for the coordinated investment and development of MNT by identifying and nurturing complementary core competencies within government, private sector and academic organizations from the CANEUS participating countries'. CANEUS is a non-profit organization catering primarily to the needs of the aerospace community by fostering the coordinated, international development of MNT (Micro-Nano- Technologies) for aerospace applications. As a 'hands on' organization, CANEUS is focused on the practical aspects of transitioning MNT rapidly and efficiently into aerospace systems. In achieving this goal, CANEUS brings together MNT developers, aerospace end-users, governmental policy makers and investors from across Canada, Europe, US and Japan.

Then, A Ortona (FN SpA, Italy) offered an overview on composite materials with ceramics matrix. This kind of materials turns out to be of particular interest in aerospace applications, as it conjugates a good behavior with respect to fracture, similar to that of metals, especially at high temperatures, with remarkably inferior material density values. A useful application in aerospace is the improvement of electrical properties of composites made of carbon nanotubes and epoxy resin; the use of such nanocomposites for electromagnetic interference shielding was the object of the talk by F Micciulla (Università di Roma 'La Sapienza', Italy). The synergies of fourteen main companies and four research centres working together in a Finmeccanica Focus Group on Nanomaterials and Nanotechnologies was described by C Falessi (SELEX-SI, Italy); this group is coordinating a Multiscale NanoScience–Engineering Integration initiative to study, design, develop and test nanotechnology based metamaterials, devices, sensors and systems. N Pugno (Polito, Torino, Italy) tackled the issue of nanotribology of biological systems involving miniaturized contacts with a very high surface to volume ratio, which suggests the feasibility of strong and reversible adhesive materials as well as of fully invisible macroscopic cables. Supersonic cluster beam deposition techniques to produce nanostructured thin films of transition metal oxides for applications where a high specific surface is needed, such as gas sensing and devices for detecting properties for volatile organic compounds and gases related to environmental pollution, was the subject of the presentation by L Seminara (SELEX-Comms, Italy). Investigations in complex structures with advanced nanomechanical tests were discussed by M Berg (Hysitron, USA).

Two sessions were devoted to biology, medicine and pharmaceuticals. A tutorial lecture by Vincenzo Balzani (Università di Bologna, Italy) introduced the audience to the topic of molecular devices and machines, as a journey into the nano world. Molecular recognition in nanosystems was the subject of a lecture by P. Baglioni (Università di Firenze, Italy) while Santina Carnazza lectured on surface bio-functionalization (by controlled ion implantation and fibronectin adsorption) aimed to enhance promonocytic cells adhesion and spatial confinement, and micro-patterning of polymer surfaces (by controlled ion irradiation on stripes of given dimensions) to obtain alignment and controlled positioning of adherent fibroblasts. The first may be important for biosensing, the latter in preparing cell-based integrated circuits, hence having an impact both in biomedicine, particularly in regenerative medicine (including tissue engineering), and in BioMEMS applications. Enrico Sabbioni (European Commission, DG JRC, Italy) introduced the topic of nanotoxicological research, emphasizing the urgent need for a safe, integrated and responsible European strategy for nanotechnology. Lina Ghibelli (Università di Roma Tor Vergata) starting from the concern about possible harmful effect of nanotubes on health, which appears justified also because of the knowledge that nanotubes react with important classes of biological molecules, such as DNA and peptides, demonstrated a deep effect of multiwall carbon nanotubes on cell viability and differentiation, providing evidence that the mechanisms involved include alteration of the cell cycle, redox alterations and mitochondrial and cytoskeletal alterations.

Cellular interactions with engineered nanoparticles are dependent on many variables, some inherent to the nanoparticle (size, shape, surface reactivity, degradation, agglomeration/dispersal, and charge) and some due to the inherent properties of the cells or tissues responding to the nanoparticle (cell type; cell surface interactions with the nanoparticle; whether cellular membranes have pores that allow or block passage of nanoparticles, cellular enzyme degradation of the outer protective surface revealing a toxic nanoparticle core; cellular storage of nanoparticles or degradation products (bioaccumulation), within the cell ultimately causing the cell's death). Functionalization and shorter exposure times increased biocompatibility; however, nanoparticle size and reactivity in relation to the type of cells and organs to be targeted seemed to be equally important. Understanding the biological effects of nanoparticles at the gross (microPET) and microscopic levels (light and electron microscopy) is essential to predict nanoparticle processing, degradation and excretion in cells, and mammalian systems in general. In this respect, Barbara Panessa-Warren's lecture provided the audience with an overview of the types of phenomena that have been reported in the literature with living cells and tissues exposed to nanoparticles, as well as new experimental data on the biological cell and tissue responses in vitro (using human lung and colon epithelial monolayers) and in vivo (in mice) to nanoparticles designed for bio-medical use (prepared with and without surface functionalization); with specific attention directed to how dose, exposure time and surface reactivity affect biocompatibility and cytotoxicity. Preventive genotoxicity approaches for a safe nano world was illustrated by Lucia Migliore (Università di Pisa, Italy), whereas A Salis (Università di Cagliari, Italy) talked about biotechnological applications of lipases immobilized onto porous materials, i.e. biodiesel production (see figure 1) and biosensors. For biosensing use the immobilization of the lipases was performed by the Cagliari group on porous Silicon.

As was done in the previous edition of the conference in 2005, selected papers, based on conference talks and related discussions, are sent for publication, after peer review, on a dedicated issue of *Journal of Physics: Condensed Matter* as one of the results of the Frascati meeting. The success of the workshop can be assessed on the basis of the level of participation (about 100 specialists coming from many different countries, from Europe to Asia, North America and most of the former Soviet Union), as well as from the high quality of the presentations. The next edition of n&n (n&n2007, under construction), is planned for October 15–17, 2007, at Villa Mondragone, Monte Porzio Catone (Rome), Italy. E-mail bellucci@lnf.infn.it.

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