## Smart Multifunctional Materials for Nanomedicine Focus Topic

## Room Ballroom A - Session SM-ThP

## Smart Multifunctional Materials for Nanomedicine and Theranostics Poster Session

**SM-ThP-1 Electrospun Alligned and Randomly Oriented Fibers Using a Novel Collector**, ***Tessa Gilmore***, *P. Gouma,* The Ohio State University

Electrospinning is a specialized processing technique for the formation of sub-micron diameter fibers of certain materials including polymers. Electrospinning may be used in the medical field, as in cases of drug delivery or tissue engineering. The orientation of the fibers, aligned or random, can affect the application of the non-woven mat due to the difference in properties. For example, aligned fibers have a higher tensile strength and modulus than randomly oriented fibers. Aligned fibers are also better suited for tissue engineering as they have improved cell proliferation and regeneration. Conversely, randomly oriented fibers are better suited for filtration applications as they can maximize separation of unwanted particulates. In this study, a novel collector and experimental setup were used to create both aligned and randomly oriented fibers during the same experiment. A solution of 15 wt% Polyvinylpyrrolidone (PVP) in ethanol was spun, and a hollow casing of fibers that surrounded the top and sides of the collector was observed. Scanning electron microscopic (SEM) images revealed that the casing had uniaxial fibers along the sides and randomly oriented fibers on the top. Additional experiments are being conducted using Cellulose Acetate (CA), which is a popularly used bioplastic. Cellulose Acetate also is known for being difficult to electrospin due to its tendency to crystalize at the extruder tip. However, this novel setup may mitigate this problem.

**SM-ThP-2 Effect of Metal-Mediated Oxidative Stress on Lysosomal Damage/Dysfunction**, *V. Sanfilippo, C. Bonaccorso, L. Cucci,* University of Catania, Italy; *R. Inturri,* Fidia Farmaceutici S.p.A., R&D Unità locale Fidia Research sud, Italy; *P. Amico,* Fidia Farmaceutici S.p.A., R&D Unità locale Fidia Research sud , Italy; *S. Vaccaro,* Fidia Farmaceutici S.p.A., R&D Unità locale Fidia Research sud, Italy; ***Cristina Satriano***, University of Catania, Italy

Lysosomes are specialized vesicles within cells that digest large molecules by hydrolytic enzymes; several studies demonstrated that metallic nanoparticles are degraded in the lysosomes with ionic release in the cytosol that induces cell damage. In this work, we reported the synthesis and characterization of plasmonic nanoparticles for subcellular targeting and intracellular imaging of lysosomes. A fluorescent and colorimetric probe (LysoBC1) was designed and synthesized for the dynamic tracking of $Cu^{2+}$ in living cells, to image lysosomal damage. The cytotoxicity and cellular uptake of metallic nanoparticles of silver and gold nanospheres (AgNS, AuNS), both bare and capped with hyaluronan, were scrutinized either on healthy (mouse fibroblast L929 line) or cancerous (human prostate cancer PC3 line) cells. The nanoparticle chemical structure and surface functionalization resulted critical to control the release of toxic species, i.e., $Ag^{+}$ ions, and the ROS generation process, which inhibits the antioxidant defense system causing mechanical damage to the cell membrane. The nanoparticles were prepared by chemical reduction methods and characterized by UV-visible spectroscopy and dynamic light scattering analyses, to study the plasmonic properties and the hydrodynamic size, respectively. The toxicity of intracellularly ions, the cellular internalization of the systems and the involvement of lysosomes in the cellular stress induced by the treatment was investigated in terms of cell viability, ROS production, and live cell-confocal imaging.

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Keywords: metallic nanoparticles, hyaluronic acid, ROS production, cell confocal imaging

**SM-ThP-3 The Interaction of Neurotrophin-Mimicking Peptides and Artificial Cell Membranes: An Experimental and Theoretical Study**, ***Vanessa Sanfilippo***, *L. Redigolo,* University of Catania, Department of Chemical Sciences, Italy; *G. Forte,* University of Catania, Department of Drug and Health Sciences, Italy; *C. Satriano,* University of Catania, Department of Chemical Sciences, Italy

In the present work we assembled hybrid peptide-nanomaterial (p-NM) systems to scrutinize their interaction at the biointerface with artificial cell membranes in 3D or in 2D, i.e., with phospholipid small unilamellar vesicles (SUVs) or supported lipid bilayers (SLBs), respectively.The peptide sequences BDNF(1-12), NT3(1-13) and NGF(1-14), encompassing the N-terminal domains respectively of Brain Derived Neurotrophic Factor (BDNF), NeuroTrophin 3 (NT3) and Nerve Growth Factor (NGF), were immobilized by physisorption onto graphene oxide (GO). The optical characterization through UV-Vis and Fluorescence spectroscopies, in terms of FRET (Forster Resonance Energy Transfer) has been made to shed light on the electron transfer processes occurring firstly at the interface between carboxyfluorescein-labelled peptides and GO (quencher of fluorescence) and then between the peptide-functionalized GO sheets (FRET donor) and the lipid membranes dye-labelled with rhodamine (FRET acceptor). The biophysical properties of the artificial cell membrane, before and after the interaction with p-NM systems, were investigated by atomic force microscopy (AFM), in terms of morphology, and by laser scanning confocal microscopy (LSM). In particular, the latter was utilized with the Fluorescence Recovery After Photobleaching (FRAP) technique, to study the average molecular lateral diffusion at the hybrid nanobiointerface. 3D optical characterization has been made through UV-Vis and Fluorescence spectroscopies, also in terms of FRET (Forster Resonance Energy Transfer) to understand the electron transfer processes. The experimental studies were paralleled by computational analyses by molecular dynamics. Cellular experiments were carried out to investigate the interaction with HUVECs cells in terms of cytotoxicity, through MTT assay, and cellular internalization, through LSM, after being treated with the p-NM. Moreover, wound closure experiments and tube formation assays were carried out to investigate the cell-migration effects and the angiogenic response induced by p-NM systems.

**SM-ThP-4 CTAB Removal and Graphene Oxide Functionalization of Metallic Nanorods for Theranostic Applications**, ***Alice Foti***, *V. Sanfilippo, P. Tomasella,* University of Catania, Italy; *L. Le Meur, T. Bretot,* University of Rennes, France; *C. Satriano,* University of Catania, Italy

Cetyltrimethylammonium bromide (CTAB) is a strong surfactant which plays a fundamental role in several procedures, such the seed-mediated growth of plasmonic nanorods.

In this respect, CTAB is used as growth and stabilizing agent as it forms bilayers on the surface of the nanorods. However, the dissociation of CTAB into $CTA^{+}$ and $Br^{-}$ makes it toxic for cells, therefore the application of nanorods in biomedical fields has some limitations. Herein, we present a strategy to remove CTAB from the metallic nanoparticle surface, followed by the replacement of the ligand with graphene oxide (GO) and reduced-thiolated GO (rGOSH), to obtain nanoparticles with a low or null level of toxicity, thus suitable for theranostic applications.

Plasmonic properties of the different systems were studied by UV-visible spectroscopy and monitored during time. The surface free energy of the CTAB-capped and CTAB-rinsed nanorods were determined by contact angle (CA) measurements and the surface charge was monitored by zeta potential (ZP) measurements. Atomic force microscopy (AFM) and dynamic light scattering (DLS) measurements were performed to investigate for size distributions and hydrodynamic size of the nanoparticles, respectively. The cytotoxicity was studied *in vitro* on different cell lines by means of cell viability detection by nuclear staining of dead/total cells and mitochondrial enzymatic activity (MTT assay). The reactive oxygen species (ROS) production was determined by MitoSOX assay, laser scanning confocal microscopy (LSM) allowed to shed light on the intracellular organelle perturbation.

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**SM-ThP-5 Hydropolymers, Hydrogels and Hydrogel Composites as Lubricants**, ***Nir Kampf***, *W. Lin, M. Kluzek,* Weizmann Institute of Science, Israel; *S. Angayarkanni,* SRMIST, India; *N. Iuster, E. Shimoni,* Weizmann Institute of Science, Israel; *R. Goldberg,* lipo-sphere, Israel; *J. Klein,* Weizmann Institute of Science, Israel

About 20% of the world's total energy consumption spent to overcome friction. Friction is also present water-based environments like biological systems, widely in hips and joints.Due to the molecular complexity of the biological systems, the mechanism of lubrication is still not clear. Apart from our efforts to find the major components responsible for the low friction in biological systems, we also try to exploit nature's solution for lubricating interfaces such as cartilage by mimicking nature's strategies of boundary lubrication, which lead to an extreme reduction of friction in aqueous environments. Low frictions failure in joints is correlated with diseases such as osteoarthritis. In my talk, I will present several examples of bio-inspired lubrication by polymers and in polymer networks. We carried out systematic investigations from the molecular to the macroscopic level, demonstrating excellent lubrication by polymer assemblies (1) and hydrogel composites (2), attributed to the hydration lubrication mechanism acting at highly-hydrated boundary layers.

1) Angayarkanni et al., (2019) Langmuir. 35, 48, p. 15469-15480.

2) Lin et al., (2020) Science. 370, 6514, p. 335-338.

**SM-ThP-6 Nanocomposites of Gold Nanoparticles-Graphene Oxide and Angiogenin for Wound Care Treatment**, *L. Chiaverini, T. Marzo,* ***Diego La Mendola***, University of Pisa, Italy

Hybrid platforms made of gold nanoparticles (AuNPs), graphene oxide (GO) nanosheets and angiogenin (ANG) protein were prepared to tune angiogenic process in the wound healing treatment.

Nanocomposites were characterized by UV-visible spectroscopy, to scrutinise the ANG binding to Au-GO, by monitoring the changes in the plasmonic peak (AuNP) as well as in the π->π* transition electronic band (GO), respectively. Atomic force microscopy and dynamic light scattering analyses confirmed a strong association of the protein to nanoparticles/nanosheets. Cellular experiments on human foreskin fibroblasts demonstrated the low cytotoxicity of the nanocomposites and theiractivity in promoting wound closure. Cell imaging by confocal microscopy revealed synergic dynamic processes modulated by the different sub-cellular structures. The obtained results evidence the promising applications of the synthesized multifunctional nanocomposites for wound care treatment.

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**SM-ThP-7 Novel Synthesis of Silver Nanoparticles and Their Antibacterial Activity for Therapeutic Applications**, *H. Arshad,* Rutgers, The State University of New Jersey; ***Umer Hassan***, Rutgers The State University of New Jersey

Silver nanoparticles (AgNPs) finds many biomedical applications due to their antimicrobial activity. Traditional material synthesis process employed to fabricate these nanoparticles require hazardous chemicals thereby posing a significant personnel and environmental risk. To mitigate this, we developed a novel eco-friendly fabrication process to synthesize silver nanoparticles using plant extracts. Here, we report the utility of Salvadora persica extract as reducing agent for nanoparticle synthesis. Further, we employed sunlight and LED irradiation methods for AgNPs fabrication. Nanoparticles were synthesized within 10 min and were characterized using multiple techniques. UV–Vis. absorbance spectroscopy analysis demonstrated spectral peaks at 450 nm corelative to AgNPs synthesis while X-ray diffraction (P-XRD) pattern depicted nanoparticles crystal structure. Fourier transform infrared spectroscopy (FTIR) demonstrated the role of phytochemicals for AgNPs reduction. Morphological analysis was done using transmission electron microscopy (TEM) and field emission scanning electron microscopy (FE-SEM) which demonstrated nanoparticles spherical shapes and revealed their size of approximately 39.7nm.

Synthesized AgNPs were extensively characterized for their antibacterial activity against Escherichia coli (E. coli) and Staphylococcus epidermidis (S. epidermidis) pathogens. Kirby Bauer antimicrobial assay was used for this analysis, and minimum bactericidal concentration (MBC) and minimum inhibitory concentration (MIC) were calculated. For E. coli MBC and MIC were determined to be 3.0 µg/mL and 1.5 µg/mL respectively. However, for S. epidermidis, these values were determined to be 25 µg/mL and 12.5 µg/mL respectively. This study highlights a novel nanoparticles fabrication method and provide their extensive characterization analysis with a focus on their role in antibacterial activity for therapeutic applications. These nanoparticles can be used to design next generation wound dressings or impregnated in surgical masks to provide enhanced antimicrobial protection.

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