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25th Nano Congress for Future Advancements

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12th Edition of International Conference on

Nanopharmaceutics and Advanced Drug Delivery

August 16-18, 2018 | Dublin, Ireland

Posters

Jong Seok Woo et al., Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Flexible superhydrophobic heater with silver nanowires and carbon nanotubes

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A smart multifunctional surface of conductive plastics with a superhydrphobic surface having porous micro- and nano-structures can potentially be very useful in many applicatioins of electrostatic dissipation (ESD), electromagnetic interference (EMI) shielding, and in transparent film heaters with self-cleaning properties. Here, we demonstrate a facile and rapid method for fabricating superhydrophobic conductive films from transparent conductive films with silver nanowires (AgNWs) and single-walled carbon nanotubes (SWCNTs) on polycarbonate (PC). This process involves the swelling of the PC surface in a dispersion of multi-walled CNTs (MWCNTs) in methly ethyl ketone (MEK), followed by coaqulation in isopropy alcohol (IPA, nonsolvent for PC). During swelling, the AgNWs and SWCNTs migrated into the plastic, and after that, the swollen PC chains were crystallized in IPA. Notably, by adding MWCNTs in MEK, the crystallization of PC chains was accelerated, and the rapid increase in the eletrical resistivity of the films was minized by reducing the formation of microstructures. Crystallization of the AgNW/SWCNT electrode onto PC and the incorporation of MWCNTs during crystallization provided a flexible superhydrophobic heater for use as a self-cleaning surface. Our results provide a very easy way to fabricate a conductive and superhydrophobic polymer surfaces with lotus-like bionic nanostuctures.

Biography

Jong Seok Woo has completed his PhD from Kyungpook University. He is the Manager of Morgan Advanced Materials in Korea. He has published more than 20 papers in reputed journals.

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Notes:

Keith Henry Moss, Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

CodeSphere: Molecular encoding of nanoparticles for targeted cargo delivery

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Conventional, untargeted and nonspecific therapies, especially regarding cancer, are commonly associated with a low therapeutic index due to poor drug efficacy and significant adverse effects. Nanoparticles (NPs) as drug delivery vehicles represent a promising strategy to overcome such shortfalls. Development in the field of NPs and clinical translation for therapeutic applications has been limited by technical and regulatory factors. Currently, there are unmet needs in the design, generation and screening of therapeutic NPs such as a consistent and reproducible synthetic technique capable of up-scaling. This is, in part, due to the vast array of parameters that each requires optimization. As a result, current strategies to optimize NPs for therapeutic applications are low-throughput and experimentally time consuming. Nucleic acids and other "hard to drugify" therapeutic macromolecules have been restricted to highly personalized therapeutic strategies such as chimeric antigen receptor (CAR) therapy and other adoptive cell therapy (ACT) applications. A breakthrough regarding the field of CAR T cell therapy would be an *in vivo* administration approach, which could potentially transform an expensive, patient specific therapy to a generic and widely-available treatment strategy, without the need for patient T-cell gene modification and expansion ex vivo. Such an innovative approach would utilize NPs to systemically deliver messenger RNA (mRNA), encoding for CARs targeting surface antigens expressed on cancer cells to T cells. The CodeSphere platform technology represents a unique strategy to generate and screen for optimized NP/liposome formulations in a high-throughput manner. The novelty in this proposed technology is the use of a DNA barcode as a unique liposome identifier. This DNA-barcode molecular-encoding system was previously developed by Bentzen et al., for the large-scale detection of antigen specific T cells and is now being applied in this new platform. In essence, liposomes will be tagged with a unique DNA barcode encoding for and identifying the composition. The CodeSphere strategy involves the generation of large, diverse DNA-encoded NP libraries which can then be screened in a single-tube assay, allowing the simultaneous assessment of thousands of different NP formulations for the most effective delivery of therapeutic cargo.

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Biography

Keith H Moss holds a BSc Degree in Biochemistry and Genetics from the University of Cape Town, RSA and an MSc in Engineering (Biotechnology) from the Technical University of Denmark (DTU). Currently, as a first year PhD student at DTU, he is engaged in the development of a novel technology platform for the identification of optimal nanoparticles for therapeutic applications. This project encompasses multiple disciplines and incorporates his interest in human disease and molecular therapeutics as well as nanotechnology and pharmaceutical drug development.

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Robert K Prud'homme et al., Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Formulation of peptide and protein therapeutics into nanoparticles by ion pairing for prolonged activity and improved delivery

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Biologics, the fastest-growing sector of the pharmaceutical marketplace, are an attractive class of therapeutics because of their impressive potency, high selectivity, and reduced off-target effects. But while the effectiveness of these drugs outclasses many of their small-molecule predecessors, administering biologics remains a challenge. Physiological barriers such as chemical digestion (when taken orally), rapid blood clearance (when injected), or thick pulmonary mucus (when inhaled) chemically or physically prevent biologics from reaching their targets and working as designed. To reduce the frequency of dosing, strategies of protecting these proteins and peptides within delivery vehicles have arisen, but the majority of these processes suffer from high losses and poor scalability. We here present a scalable and continuous method of encapsulating water-soluble charged biologics into polymeric nanoparticles. This is done by simultaneously reversibly ionically modifying the biologics of interest with hydrophobic counterions and controllably precipitating the newly-formed hydrophobic complex into nanoparticles via the polymer-directed Flash NanoPrecipitation technique. This combined technique, termed hydrophobic ion pairing Flash NanoPrecipitation (HIP-FNP), is applicable to a wide variety of peptides and proteins, both anionic and cationic. Importantly, the process is continuous, scalable, and achieves encapsulation efficiencies greater than 95%. We herein demonstrate encapsulation of two model proteins: the cationic enzyme lysozyme (MW 14,300 D) and the anionic protein ovalbumin (MW 42,700 D). By altering the identity or amount of hydrophobic counterion used, we can tune protein release rates, an important consideration for prolonged delivery. Importantly, we also show that the proteins' activity has been retained throughout the processing steps. We believe this technique offers a route forward for improving the delivery of many biologic therapeutics and may improve patient comfort and compliance by simplifying dosing regimens.

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Biography

Robert Prudhomme is a Professor in the Department of Chemical and Biological Engineering at Princeton University, USA. He is the Founding Director of the Program in Engineering Biology. His research program focusses on polymer self-assembly applied to drug delivery. The development of Flash Nanoprecipitation (FNP) in his laboratory enabled the encapsulation of poorly soluble drug compounds and oligonucleotides for therapy directed towards cancer, TB, and injections. FNP is a scalable and continuous process that is enables integrated processing and spray drying for low cost oral and aerosol formulations. Under sponsorship by the Bill and Melinda Gates Foundation, the process is being adopted to formulate new compounds coming from TBA, MMV, and DNDi.

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Juliana Damasceno Oliveira et al., Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Characterization, stability and cell viability tests on ionic-gradient liposomes designed for the delivery of etidocaine

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Statement of the Problem: Liposomes are lipid carriers widely used in drug-delivery, and a number of liposome-based products have been approved for clinical application, so far. Local anesthetics interact with liposomes, distributing themselves in the lipid bilayer and in the inner aqueous core, prolonging the anesthesia time. In ionic gradient liposomes (IGL) the ionizable drug is loaded in preformed vesicles that exhibit a trans-membrane ionic gradient leading to high drug upload and, subsequently, prolonged drug release.

Objectives: The objective of this work is to develop IGL for the sustained release of etidocaine (EDC).

Methodology: Large unilamellar vesicles (LUV, 20 mM) composed of soy phosphatidylcholine:cholesterol (6:4 mol%) plus 250 mM sulfate gradient, were prepared for the upload of 0.5% EDC. Dynamic light scattering (DLS), nanotracking analysis (NTA) and transmission electron microscopy (TEM) were used to characterize the liposomes' size, polydispersity (PDI), zeta potential (PZ) and number of particles. The *in vitro* release of EDC was measured in Franz diffusion cells, at 37°C. Cell-viability assays were done in primary cell cultures (Schwann or sciatic nerve cells from Wistar rats).

Results: IGL were successfully prepared with size, PDI, PZ and concentration in the range 500 nm, 0.2 and -20 mV, and 4-5.10^{12}, respectively, and they kept stable over 60 days at 37±37°C. TEM data revealed the spherical morphology of the liposomes that was able to encapsulate 41% of EDC. At 37°C, the time for 100% release of the anesthetic increased from 3 h (EDC in solution) to 24h in IGL_{EDC}. Cytotoxicity tests revealed that encapsulation into liposomes decreased the intrinsic toxicity of the anaesthetic.

Conclusions: IGL are very interesting carriers for the delivery of local anesthetics. In this study sulphate-gradient LUV (large unilamellar vesicles) were found promising increase the upload, and release of etidocaine. *In vivo* tests are under course to evaluate the antinociceptive effects of the formulation.

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Biography

Juliana Damasceno Oliveira completed her Bachelor's Degree in Pharmacy. She is currently a PhD student in the Department of Biochemistry and Tissue Biology at the Institute of Biology of University of Campinas (UNICAMP), Brazil. She has experience in the areas of pharmacology, biochemistry and pharmaceutical technology - working in the development of drug-delivery systems, DDS, mainly ionic gradient liposomes – and biophysical methods applied to the study of the structural, physicochemical, mechanical and biological properties of DDS.

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Samaneh Kabirian Dehkordi et al., Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Anticancer activity of G rich aptamer AS1411 grafted to gold nanospheres: From synthesis to mechanism study

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AS1411 is a G-rich oligodeoxynucleotide aptamer that has been used in phase II clinical trials for the potential treatment of cancers. Forming a G-quartet structure, AS1411 binds to cell surface nucleolin specifically, and is subsequently internalized into the tumor cell. It remains unclear how AS1411 binding to nucleolin leads to cell proliferation inhibition and cell death. Despite remarkable AS1411 results in a few patients, the overall rate of response has been low, possibly because it has less than optimal pharmacology and relatively low potency. Attaching AS1411 to gold nanospheres (AS1411-GNSs) increases its accumulation in cancer cells and enhances its antitumor efficacy by binding to cellular nucleolin. Nucleolin is associated with ribosomal DNA (rDNA) and is absolutely required for rRNA synthesis. It binds with nanomolar affinities the G-quadruplex rDNA sequences to increase the rate of RNA polymerase I (POL1) transcription. We developed a new complex of AS1411 conjugated to Gold nanospheres (GACGs). This complex was more stable and effective than AS1411 in treated tumor cell lines. GACGs decrease nucleolin expression affecting tumor cell proliferation and POLI targeting genes transcription such as 5'ETS and 18s. Thus, GACGs targeting Nucleolin/rDNA complexes inhibit POLI and represents a novel, nucleolar targeting approach to selectively disrupt proliferation in cancer cells and induce cell death.

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Biography

Samaneh Kabirian, a Chemist completed her Bachelor's Degree in Pure Chemistry; Master's Degree in Analytical Chemistry (detection of biomolecule in blood). She has her expertise in synthesis, characterization of nanoparticles conjugated to aptamers and passion in improving its application in biology of cancer. She is always curious and enthusiastic to work on multidisciplinary project and bridging gap between different domains of science. She is currently pursuing a double degree PhD in Molecular and Cellular Biology at the University of Lyon (France) and in Analytical Chemistry at Isfahan University (Iran). She has been studying and working in biochemistry and biology laboratory of cancer research center of Lyon (France) for the past 3 years. She gave her a good point of view to biological aspects of applications of nanoparticles in biology of cancer. With strong background in chemistry and specially analytical chemistry, she is also trained in all common molecular and cellular biology manipulations like cell culture, protein and DNA analysis and so on. Her double skilled ability helps build a good connection in multidisciplinary project especially cancer biology and pharmaceutical chemistry.

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Robert K Prud'homme, Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Nanomedicine: From high tech to global health

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Nanotechnology in drug delivery has a schizophrenic dichotomy of goals. One goal is to make drugs more bioavailable, which is normally associated with oral drug delivery. This bioavailability is associated with rapidly releasing drugs. The goal is achieved by making nanocarriers (NCs) with high surface-to-volume ratios, and with the drug in an amorphous state. The other goal is to encapsulate and deliver drugs to specific disease sites. This requires retaining the drug in the NC until targeted delivery is achieved. We will discuss examples of nanoparticle formulations based on our rapid micromixing platform – Flash Nanoprecipitation (FNP)– that address both of these goals. Targeted, sustained-release NCs require degradable block copolymers that enable targeting, but also clearance. Sustained release is achieved either by making insoluble ion pairs or through pro-drug synthesis. Enhanced dissolution, for oral delivery of poorly bioavailable therapeutics, requires the development of low-cost NC stabilizers. We demonstrate NC formation using lecithin, HPMC, and the corn protein, zein. The coupling of FNP to a spray drier enables a continuous, integrated, one step and scalable process for the production of powders for oral administration. The unexpected stability of these NC powders to high temperature and humidity, and the scalability of the platform were major reasons that the Gates Foundation has funded our group to prepare NC formulations of several drugs coming through their pipeline. While FNP was initially developed for encapsulation of hydrophobic actives, soluble peptides and proteins are now the fastest growing segment of the pharmaceutical market. We will present a new inverse Flash Nanoprecipitation process (iFNP) which enables encapsulation of peptides and biologics at 90% loading with 95% loading efficiency. The encapsulation at these loadings has not been achieved by other technologies.

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Biography

Robert Prudhomme is a Professor in the Department of Chemical and Biological Engineering at Princeton University, USA. He is the Founding Director of the Program in Engineering Biology. His research program focusses on polymer self-assembly applied to drug delivery. The development of Flash Nanoprecipitation (FNP) in his laboratory enabled the encapsulation of poorly soluble drug compounds and oligonucleotides for therapy directed towards cancer, TB, and injections. FNP is a scalable and continuous process that is enables integrated processing and spray drying for low cost oral and aerosol formulations. Under sponsorship by the Bill and Melinda Gates Foundation, the process is being adopted to formulate new compounds coming from TBA, MMV, and DNDi.

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Regina Herma, Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Phosphonium carbosilane dendrimers: Efficient non-viral vectors for siRNA delivery to adenocarcinoma cells *in vitro*

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Gene therapy is a rapidly growing field of biomedical research which has sparked great interest because it offers the possibility of a permanent cure a variety of genetic-based diseases. The success of gene therapy depends on the development of suitable vectors for the delivery nucleic acids into cells. Our work is focused on the comparative study of the two types of cationic carbosilane dendrimers terminated with the ammonium and phosphonium groups for their use as non-viral vectors for siRNA transfection. We present a part of work devoted to characterization of dendriplexes formed from generation 1-3 (G1-3) of carbosilane dendrimers and model siRNA. We used a number of biophysical methods (e.g. Gel retardation electrophoresis, DLS, ξ (zeta)-potential, AFM) for characterization of dendriplexes. Transfection efficiency was evaluated by Fluorescence Microscopy and Flow Cytometry. Both types of dendrimers G2-G3 form stable complexes with siRNA due to positive charge of surface groups of dendrimers and negative charge of siRNA backbone. Formation of dendriplexes was investigated at different charge ratio (1/5 – 10/1 (+/-)) to find the optimal properties of complexes (e.g. stability, surface charge, dimensions) for transfection of cells. *In vitro* transfection experiments proved the ability of both G3 dendriplex structures to enter the cells, with maximal achieved transfection efficiency at 7/1 (+/-) charge ratio. Ammonium dendrimers achieved max. 30% of transfected cells. More than 70% of cells were transfected under the same conditions with phosphonium terminated dendrimers. With the aim to optimize the properties of phosphonium dendriplexes we incorporated new periphery substituents ($P(Et_2)_2(CH_2)_3OH$, $P(Ph)_3$, $P(C_6H_4\text{-}OMe)_3$, PBu_3) into dendrimer structure. Similar cytotoxicity (except PBu3) and transfection efficiencies were obtained with the exception of P(Ph)3 peripheral substituent. This type of dendrimer exhibits more than 80% transfection efficiency and seems to be the "hot" candidate for further improvements of gene delivery by phosphonium carbosilane dendrimer vectors

Recent Publications

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Biography

Regina Herma is PhD candidate at Jan Evangelista Purkyne University(UJEP),Czech Republic. Her work is mainly focused on the effect of type, generation and surface modification of carbosilane dendrimers on the interaction with selected nucleic acids for applications in biomedicine (transport molecules for drug targeting, vectors for gene therapy, potential treatment of lung cancer). She is part of a research team for a number of projects.

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Nanopharmaceutics and Advanced Drug Delivery

August 16-18, 2018 | Dublin, Ireland

e-Poster

Fatemeh Radmanesh et al., Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Optimizing transfection of primary human umbilical vein endothelial cells using facial amphipathic deoxycholic acid conjugated polyethyleneimine

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[2]Shahid Beheshti University of Medical Sciences, Iran
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Introduction: Currently, RNA interference (RNAi) based gene therapy has been investigated for treating various disease conditions. However, successful application of RNAi including siRNA or miRNA has been limited by several factors *in vitro* and *in vivo*. To overcome these challenges, various non-viral carriers have been developing for efficient RNAi-mediated gene silencing. However, it is necessary to improve the efficacy of these non-viral strategies to achieve desired therapeutic effect. In this study, we carried out synthesis, characterization, and optimization of a polymeric conjugate based on low molecular weight polyethylenimine which was modified by high membrane permeable deoxycholic acid conjugated polyethylenimine (DA PEI) for efficient delivery of RNAi-based therapeutics into primary human umbilical vein endothelial cells (HUVECs).

Methodology: Herein, DA-PEI conjugate was synthesized based on DCC/NHS chemistry at various DA to PEI molar ratios of 2 to 4 and used for delivery of a fluorescent labeled siRNA into HUVECs. Conjugates were characterized for chemical structure, size, and cell cytotoxicity. The effect of various parameters including DA/PEI molar ratio, polymer/siRNA weight ratio, and different buffer solutions was investigated on transfection efficacy of conjugates.

Results: DA was conjugated to the terminal amine groups of the PEI 1.8 via amide bonds. The polyplexes had smaller sizes (about 130~150 nm) than the parent PEI 1.8 at different weight ratios. MTS assay revealed that the conjugates were non-toxic at polymer concentrations used in transfection experiments. The higher intracellular uptake and transfection efficiency were achieved by the conjugates synthesized in DA/PEI molar ratio of 3 or 4, polymer/siRNA weight ratio of 5 when they were prepared in salty buffers.

Conclusions: These results suggest that the DA-PEI 1.8 conjugate can be applied as a promising candidate to enhance delivery of RNAi therapeutics into primary endothelial cells under the optimized transfection conditions.

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Biography

Fatemeh Radmanesh pursued BSc Biotechnology and MSc Microbial Biotechnology from University of Isfahan, Iran. She is currently a PhD student of Medical Biotechnology at Shahid Beheshti University of Medical Sciences. She is a Member of Royan Cardiovascular and Cell Engineering Group. She is interested in nanoparticulate delivery strategies, especially for RNAi-based therapeutics delivery. She joined Royan Institute in 2015 and pursued PhD thesis on using polymeric nanoparticles to deliver RNAi therapeutics.

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12th Edition of International Conference on

Nanopharmaceutics and Advanced Drug Delivery

August 16-18, 2018 | Dublin, Ireland

Accepted Abstracts

Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Multi-functional magneto-liposomes for photo-thermally triggered drug release and MRI imaging

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Magnetic nanoparticles exhibit extraordinary properties, which make an excellent candidate for biomedical applications. Iron oxide nanoparticles have been used in MRI imaging, drug delivery and cancer hyperthermia. In the present work we report the engineering of hybrid vesicular systems between temperature-sensitive liposomes (TSL) and magnetic nanoparticles, as promising smart nanocontainers for photo-thermally triggered drug release and magnetic resonance imaging. Superparamagnetic iron oxide nanoparticles with different compositions, core sizes, and surface coating were successfully incorporated into TSL. Liposome-iron oxide hybrids (magneto-liposomes) were prepared using lipid film hydration and extrusion, and doxorubicin (Dox) was encapsulated in the liposome aqueous core using a remote loading method. The developed magneto-liposomes were characterized using dynamic light scattering (DLS), transmission electron microscopy (TEM), inductively coupled plasma mass spectrometry (ICP-MS). Dox release from our novel hybrids was assessed in response to near infrared radiation (NIR) laser. Magneto-liposomes were also studied to evaluate their capabilities as magnetic resonance imaging (MRI) contrast agent. Our results revealed that the incorporation of small hydrophobic SPIO in the TSL lipid bilayer did not affect liposome size, stability and Dox loading. Moreover, our magneto-liposomes showed fast drug release in response to laser, and superior MRI imaging capabilities compared to free SPIO nanoparticles. In conclusion, we report, for the first time, novel magneto-liposomes that could be used as a laser-responsive system, and can be combined with MRI for image-guided drug delivery.

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Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Developing targeted liposomal vaccines

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Pattern recognition receptors, including the Toll-like receptors (TLRs), are important in the induction and activation of two critical arms of the host defense to pathogens and microorganisms; the rapid innate immune response (as characterized by the production of Th1 cytokines and type 1 interferons) and the adaptive immune response. Through this activation, ligands and agonists of TLRs may offer advantages as vaccine adjuvants offering enhanced immunotherapeutic efficacy. However, incorporation or encapsulation of these TLR agonists within delivery systems, such as liposomes, would be beneficial due the importance of local maintenance of the agonist at the site of antigen administration for optimal adjuvant activity to be achieved, without systemic distribution throughout the host. Resiquimod is a small (water-soluble) agonist of the endosome-located Toll-like receptor 7 (TLR7), therefore upon injection it will rapidly distribute throughout the body rather than staying at the injection site. In this present study, resiquimod has been chemically synthesized with DSPE lipid to form a lipid=TLR agonist conjugate before further being incorporated within the cationic liposomes composed of dimethyl dioctadecyl ammonium bromide (DDA) and the immune-stimulatory glycolipid trehalose 6,6′ -dibehenate (TDB). The liposomes formulated with and without the conjugated TLR7 ligand displayed similar vesicle characteristics and conjugation of resiquimod resulted in strong retention of both resiquimod, as well as adsorbing the TB subunit vaccine Ag85B-ESAT6-Rv2660c (H56). Following vaccine delivery through the intramuscular route a depot at the site of injection was formed promoting controlled release and drainage of delivery system and TLR agonist to the popliteal lymph node. Immunization studies have shown that this bio-distribution profile translates into increased Th1 responses, as well as down-regulation of Th2 responses both at the spleen, injection site and draining popliteal lymph node.

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Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Regression of prostate tumors after intravenous administration of targeted gene based nanomedicines

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The possibility of using gene therapy for the treatment of prostate cancer is limited by the lack of safe delivery systems able to selectively deliver therapeutic genes to tumors by intravenous administration. Given that lactoferrin receptors are overexpressed on prostate cancer cells, we hypothesized that the conjugation of lactoferrin to generation 3 diaminobutyric polypropylenimine dendrimer would improve its transfection and therapeutic efficacy in prostate cancer cells. In this study we demonstrated that the grafting of lactoferrin to the dendrimer led to an enhanced anti-proliferative activity of the dendriplex by up to 5.8-fold in PC-3 cells compared to the unmodified dendriplex *in vitro*. *In vivo*, the intravenous administration of lactoferrin-bearing DAB dendriplexes encoding TNFα resulted in the complete suppression of 70% of PC-3 and 50% of DU145 tumors over one month. Treatment with DAB-Lf dendriplex encoding TRAIL led to tumor suppression of 40% of PC-3 tumors and 20% of DU145 tumors. Tumor suppression was also observed for 20% of both types of prostate tumors following injection of DAB-Lf dendriplex encoding IL12. The treatment was well tolerated by the animals. Lactoferrin-bearing generation 3 polypropylenimine dendrimer is therefore a highly promising delivery system for the gene therapeutic treatment of prostate cancer.

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Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Apoferritin cage nanostructure as the anthracycline delivery system

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Cancer diseases are undoubtedly the most complex diseases known to humanity and one of the greatest problems of the 21st century. The continuous increase in cancer cases is a serious problem in the sphere of prophylaxis and treatment. According to the WHO data, in 2012, the number of newly diagnosed cancer cases was as high as 14 million and the estimated number of new cases per year will increase to 22 million over the next twenty years. During the same period, deaths are projected to increase from 8.2 million to 13 million per year. The strategy of treating cancer is based on three basic methods: tumor removal, toxic chemotherapy and radiotherapy. The most developed method is chemotherapy. However, many anticancer drugs are causing serious side effects. To address the problems with conventional drugs and improve their pharmacological properties, drug-delivery systems (DDS) have been designed for a number of drug-carrier platforms including synthetic (silica, polymers) and natural (lipids, proteins, oligosaccharides) nanocarriers. The most recent development in designing DDS have been focused upon the protein-based nanomedicine platform, due to merits that include high biocompatibility, biodegradability, high solubility, and ease of surface modification. One of the most investigated classes of protein-nanocages is ferritin, which in biological system is used to store iron and to keep it from building to toxic levels in cells. Ferritin/Apoferritin (APO) nanocages have been used to encapsulate a variety of drugs and biologically active substances, including gadolinium contrast agents, doxorubicin, inorganic and magnetite nanoparticles, photosensitizers, organometallic CO releasing systems containing Ru and Mn. Here, we present a drug delivery system to protect the anthracyclines cancer drugs in the apoferritin nanocage. Anthracyclines are the class of drugs used to treat many cancers, including leukemias, lymphomas, breast, stomach, uterine, ovarian, bladder cancer, and lung cancers. Their main adverse effect is cardiotoxicity, which considerably limits their usefulness. Here, we demonstrate the differences in the releasing process of anthracyclines (doxorubicin, epirubicin, daunorubicin and idarubicin) from the APO nanocages. The APO-drug nanocages were prepared by disassembly/reassembly process via pH method. The pH-dependent anthracyclines release was determined using fluorescence spectroscopy.

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Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Development of novel versatile theranostic platforms based on titanate nanotubes: New safe nanovectors for drugs, plasmid DNA and imaging probes

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The concept of nanomaterials that can be designed and administered into the human body to improve health is of great interest. During the past years there has been an increasing amount of research on the uses of nanomaterials in diverse areas of biomedical research including biological sensing, labelling, imaging, cell separation and therapy. In this conference, the first evaluation of titanate nanotubes (TiONts) as potential carriers of therapeutic molecules will be presented. Our research group has developed TiONts with controlled parameters from a hydrothermal synthesis and explored biomedical applications over the last decade. These nanotubes are currently elaborated as stable suspensions of nanocarriers by surface chemistry engineering, they can be used as novel transfection agents for cardiomyocytes and we have shown that TiONts are capable of increasing the ionizing effect of radiation therapy in the case of glioblastoma. Furthermore, TiONts' biodistribution has already been evaluated by SPECT/CT in male Swiss nude mice and TiONts are quickly excreted. More recently we have demonstrated that TiONts-docetaxel (DTX) nanohybrids are versatile nanocarriers in order to limit the systemic toxicity of taxanes and to improve the selectivity of radiotherapy (RT). Our strategy is based on the intraprostatic injection of the TiONts-DTX nanohybrids both in place of brachytherapy and in combination with RT. This is achieved by taking advantage of the TiONts morphology as well as their radiosensitization effect and by associating them with docetaxel molecules, also recognized for their potential to radiosensitization. We also grafted the surface of TiONts with gold nanoparticles, for a resulting combined radiosensitizing effect. Biodistribution kinetics showed that more than 70% of nanohybrids were localized into tumors 96 hours after injection. Mice receiving nanohybrid-RT exhibited a significant tumor growth delay compared to mice receiving free DTX-RT. The elaboration of nanohybrid materials, intended for drug delivery systems, based on TiONts coated with chitosan polymer has also been evaluated. Such nanotubes are combined with transresveratrol derivatives for their anti-oxidizing and antitumor effects.

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Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Synthesis, functionalization and characterization of mesoporous silica nanoparticles for intravenous doxorubicin delivery to cancer cells

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Chemotherapy treatment of cancer has proved beneficial in increasing survival rate compared to radiation therapy, surgery, and photodynamic therapy because the drugs are spread all over the body. However, conventional chemotherapy is toxic to normal cells and requires very long treatment periods and cycles. Curative chemotherapy of human malignancies is also hindered mainly by multi-drug resistance (MDR) and other chemo-resistance properties exhibited by the body. The purpose of this study is to develop multifunctional drug carriers that can encapsulate, prevent premature drug release, and actively and specifically release the drugs in a stimuli-responsive way. Mesoporous silica nanoparticles were synthesized by the sol-gel method, functionalized by double bilayers of alginate and chitosan using the layer-by-layer technique and finally conjugated with folic acid. Drug loading, *in vitro* drug release in phosphate buffered saline and acetate buffers, *in vitro* cytotoxicity assay, intracellular uptake and drug internalization by living cells were investigated. Relatively high drug encapsulation efficiency and loading capacity of 53% and 2.3% were achieved at pH 5. *In vitro* drug release confirmed absence of doxorubicin release by the carrier at blood pH of 7.4 while an initial burst release was observed at acidic pH followed by a sustained drug release over a 36 hour period. MTT assay showed the biocompatibility of the drug carrier while confocal laser scanning microscopy proved the hyper uptake and internalization of the multifunctional drug carrier. Exposure of free doxorubicin drug, drug loaded carrier with and without folic acid on the surface to tumour cell line and normal HeLa cells, before and after folic acid blocking, showed the efficient folic acid receptor assisted drug internalization by the tumour cells. The investigation offered a practical route to the fabrication of biocompatible, pH responsive targeted active and sustained doxorubicin delivery to tumour cells.

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Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

A nanostrategy for characterizing the phenotypic evolution of circulating tumor cells during therapy

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Targeted therapies have been proved to be effective in cancer treatment but are limited by the rapid acquisition of drug resistance (within months). A rapid and non-invasive method to monitor drug response would promote precision medicine and improve treatment efficacy. Circulating tumour cell (CTC) analysis has emerged as a useful monitoring tool, but its routine usage is restricted by either limited multiplexing capability or sensitivity. Here we demonstrate the use of antibody-conjugated and Raman reporter-coated gold nanoparticles for simultaneous labelling and monitoring of multiple CTC surface markers (named as "cell signature"), without the need for isolating individual CTCs. Our nanostrategy is capable of detecting 10 tumor cells in 10 mL of blood. We also observe cell heterogeneity and phenotypic changes of melanoma tumor cells during molecular targeted treatment. Furthermore, we follow the CTC phenotypic changes of 10 stage-IV melanoma patients receiving immunological or molecular targeted therapies. Our technique maps the phenotypic evolution of patient CTCs and shows drug-resistant clones having different CTC signatures of potential clinical value. We believe our proposed method is of general interest in the CTC relevant research and translation fields.

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Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Major role of complement activation compared to protein corona composition in the capture of stealth-NP by phagocytes: Inter-individual and inter-species variability

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Understanding the functional properties of a new nano-biointerface created by host proteins adsorbed on nanoparticles (NPs), or nanoparticle protein corona, masking the pristine nanomaterial is considered by many the obliged "golden gate" to their clinical application. Rapid clearance by the reticular endothelial system (RES) phagocytes is a major obstacles for nanotheranostics developments and the protein corona may indeed favor or hamper such process. However, also complement activation may increase RES clearance and contribute to proinflammatory and infusion-related reactions. Poly(ethylene glycol) (PEG) NPs coatings, used to minimize protein interaction and RES clearance (stealthing effect) may trigger complement, thereby improving phagocytes capture and infusion-related reactions. Poly(2-mehyl-2-oxazoline) (PMOXA) and poly(2-ethyl-2-oxazoline) (PETOXA) have been proposed as alternative polymer for NP surface modification, due to their improved chemical/physicochemical features compared with PEG. We characterized PEG, PMOXA and PETOXA performance and evaluated the relative importance of protein corona formation vs complement activation. Specifically, we tested the efficacy of human monocytes, macrophages and PMNGs to capture 100 nm ORMOSIL-NPs, coated with above indicated polymers, in human serum. PEG and, especially, PMOXA and PETOXA coatings increased complement activation and opsonine-mediated NP capture by phagocytes compared to naked NPs. The surface-dependent composition diversities of the serum protein corona formed on the different NP formulations were poorly relevant since, in the absence of complement, a similar stealth effect was invariably measured. Tests using sera from different human subjects, mice and pigs showed crucial subject- and species-dependent differences. We conclude that complement cascade activation is a major factor negatively affecting the stealthing efficacy of PEG, PMOXA and PETOXA coats on NPs. Species-specific diversities of such mechanisms in pre-clinical models, e.g. the murine one, may lead to wrong NP efficacy extrapolations to the human contest. This demands the search for complement-inert nanoparticle coatings.

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Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Multifunctional bioinspired nanocarrier based targeted therapy for lung cancer

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Statement of the Problem: Despite an increased understanding of pathophysiology and advanced therapies, the success rate in the treatment of lung cancer remains unsatisfactory. Conventional therapies are rarely successful due to limited amount of drug reaching the tumor site even administered at a high dose and associated toxic effects. Therefore, site-specific targeted delivery of therapeutically active agents to the tumor cells is the most crucial step for the effective treatment of lung cancer. The aim is to develop aerosolized Celecoxib loaded lipid nanocarriers (Cxb-NLC) and evaluate *in vitro* and *in-vivo* anticancer activity of as a single therapeutic agent and combined with intravenously administered Docetaxel (Doc) against non-small cell lung cancer. Our approach is to deliver the chemodrugs using targeted biodegradable lipidic biomaterial based nanocarriers via inhalation route of administration to tumor cells while sparing normal cells. The high-pressure homogenization was used for nanocarrier preparation and characterized for its physicochemical characteristics. The *in vivo* A549 tumor model in Nu/Nu mice was used to evaluate the efficacy. The particle size of Cxb-NLC was 217±20nm, while entrapment efficiency was > 90%. Cxb-NLC and Doc alone and in combination showed 25±4 %, 37±5 %, and 67±4 % reduction in tumor size respectively compared to control. Proteomic analysis with combination treatment further revealed significantly decreased expression of multiple pro-survival and pro-metastasis proteins. Cxb-NLC and Doc combination therapy showed significant reduction in tumor growth which was further confirmed by proteomic analysis. The *in vitro*, lung cancer orthotopic tumor models studies confirm the enhanced efficacy of developed targeted nanocarriers.

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Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

An optically tunable STDP synaptic plasticity memristor based on hybrid organic-inorganic materials

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Memristors are one of the most promising nanoscale candidates' technologies for future applications in data storage, logic and neuromorphic computing networks. Modulation of their electronic properties by optical stimuli provides a new level of functional control, enabling the development of new types of optoelectronic devices and circuits, such as photonic integrated circuits with memory elements controllable by light. Memristors too have important applications in neuromorphic computing, and in this context, the dynamic and spatial patterning by light opens the route to new optically configurable and tunable synaptic circuits. Here, we demonstrate a novel optically controllable organic-inorganic hybrid memristor device consisting of vertically aligned ZnO nanorods embedded within an optically active polymer, poly (disperse red 1 acrylate) (PDR1A). Illumination by polarization and wavelength-specific light induces trans-cis photo isomerization of the azobenzene molecules causing an expansion or contraction of the material, which modifies the resistance of the on/off states, their ratio and retention times. We demonstrate optical control of short-term and long-term memory and tunable learning through spike timing dependent (synaptic) plasticity (STDP). We believe this has important applications in the dynamic patterning of memristor networks, whereby both spatial and temporal patterning via light allows the development of new optically reconfigurable neural networks, adaptive electronic circuits and hierarchical control of artificial intelligent systems.

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Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Cancer nanotechnology: Gold nanostructures as a platform for combinational therapy in future cancer therapeutics

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The field of nanotechnology is currently undergoing explosive development on many fronts. The technology is expected to generate innovations and play a critical role in cancer therapeutics. Among other nanoparticle (NP) systems, there has been tremendous progress made in the use of gold nanostructures in cancer therapeutics. In treating cancer, radiation therapy and chemotherapy remain the most widely used treatment options and recent developments in cancer research show that the incorporation of GNPs into these protocols has enhanced tumor cell killing. These nanostructures further provide strategies for better loading, targeting, and controlling the release of drugs to minimize the side effects of highly toxic anticancer drugs used in chemotherapy and photodynamic therapy. In addition, the heat generation capability of gold nanostructures upon exposure to UV or near infrared light is being used to damage tumor cells locally in photothermal therapy. Hence, gold nanostructures provide a versatile platform to integrate many therapeutic options leading to effective combinational therapy in the fight against cancer. In this presentation, the recent progress in the development of gold-based nanostructures towards improved therapeutics will be discussed. A multifunctional platform based on gold nanostructures with targeting ligands, therapeutic molecules, and imaging contrast agents, holds an array of promising directions for cancer research.

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Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Bioinspired materials templates by nature species

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After millions of years' evolution, natural species have developed an astonishing variety of sophisticated nanostructures that are difficult to fabricate even with the most technologically advanced synthetic methodologies. Inspired from natural materials with hierarchical structures, many functional materials are developed using various templating methods. This review will introduce how to fabricate novel functional materials based on natural bio-structures with a great diversity of morphologies, in State Key Lab of Metal Matrix Composites, Shanghai Jiao Tong University in the latest five years. We will focus on replicating the natural component with functional inorganic materials while maintaining the morphologies of the biological species (e.g. wood, agriculture castoff, butterfly wings). Properties of the as-required materials will be systematically studied. Based on these results, we will discuss the potential applications of these materials in manipulation of light propagation, solar cells, electromagnetic shielding, energy conversion, and gas sensors, et al. In addition, the fabrication methods could also be applied to many other natural templates that could eventually lead to the production of optical, magnetic, and electric devices as building blocks for nano-electronic, magnetic, or photonic integrated systems. These bioinspired functional materials with improved performances are becoming increasing important, which will be extremely valuable in developing functional materials with novel nano-morphologies in the near future.

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Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Architecture and interface design for high conductive graphene/copper composites

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Recently, tailoring properties by architecture design that changes the spatial distribution of reinforcement in matrix at micro/nano-scale without changing constituents has attracted intensive attention in the community of composite. Natural biological materials are characterized by combining simple constituents into a wide variety of composites with a maximum of control over architecture on many length scales, exhibiting a remarkable range of mechanical and functional properties. Understanding the role that multilevel architectures play in controlling properties of natural materials may serve as inspirations for architecture design in composites. Metals can be strengthened by adding hard reinforcements, but such strategy usually compromises ductility and toughness as well as electrical/thermal conductivity. In past few years, a bioinspired strategy has been applied to surmount the dilemma in our research. By assembling copper nanoflakes cladded with graphene, graphene/copper matrix composites with a natural nacre inspired nanolaminated architecture have been prepared. Owing to a combined effect from the bioinspired nanolaminated architecture and improved interface bonding, a tradeoff has been made between mechanical strength and ductility as well as electrical/thermal conductivity in graphene/copper matrix composites. The bioinspired nanolaminated architecture enhances the mechanical strengthening and electrical/thermal conducting efficiencies of two-dimensional graphene by alignment of graphene that orient to maximize performance for required loading and carrier transporting conditions, and toughening by crack deflection. The strategy sheds light on the development of structural-multifunctional integrated composites.

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Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Synthesis and electrochemical investigation of cubic structured Fe-doped-$SrCoO_3$ nanocomposite cathode for LT-SOFC

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Low-temperature solid oxide fuel cell (LT-SOFC) is one of the most favorable energy conversion systems that are need of hour. The advancement in field of LT-SOFC requires a highly efficient, oxygen permeable, good electro-chemical cathode. The SCF (Sr0.3Co0.6Fe0.1) oxide composite cathode was prepared by environmental friendly sol-gel method. The crystal structure of prepared materials was analyzed by x-ray diffractometry, while structural characteristic were studied by Fourier transform infra-red spectroscopy (FTIR). The particle size was calculated by Scherer's formula and found to be 36 nm. The results were also confirmed by SEM images. The prepared material showed porous coral reef like surface morphology in recorded scanning electron micrograph. The activation energy was calculated by Arrhenius curve that is 3.0×10^{-2} eV and highest electronic conductivity measured and calculated was 24.01 S/cm. SCF oxide cathode was tested for potential LT-SOFC between the range of 450°C-650°C temperature. The maximum current density and power density obtained at 650°C was 887 mAcm-2 and 110 mWcm-2 respectively.

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Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Low-temperature SnO_2-modified TiO_2 yields record efficiency for normal planar perovskite solar modules

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Hybrid organic-inorganic perovskite solar cells (PSCs), particularly for the planar PSCs, attracted significant attention because of their high efficiency, low fabrication costs, and simple preparation process. However, planar PSCs exhibit lower efficiency and stability than mesoporous PSCs, primarily owing to defects in the electron transport layer (ETL). Here, we introduce a SnO_2 nanoparticle modified TiO_2 film (SnO_2@TiO_2) as the ETL. In addition, we propose a simple three-step chemical bath method to achieve such SnO_2@TiO_2 structure at low temperatures (140°C). The SnO_2@TiO_2 ETL significantly enhances the electron extraction and decreases the trap states at the perovskite/ETL interface. We achieved average efficiencies at reverse scan and forward scan of 21.27%, 19.79%, 17.21% and 16.31% for device area of 0.10 cm2, 1.13 cm^2, 5.25 cm^2 and 10.56 cm^2 respectively. Besides, we achieved a certificated efficiency of 15.65% for the normal planar perovskite solar module with masked area of 10.55 cm^2. The SnO_2@TiO_2-based PSCs exhibit enhanced photocurrent and reduced hysteresis. Furthermore, the solar cell retained about 89% of its initial efficiency after about 750 hours of aging in dark and about 93% for 528 hours under full-sun illumination. Because of the low-temperature processability and the absence of spin-coating steps, SnO_2@TiO_2 ETLs will provide a promising path for the commercialization of PSCs.

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Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Investigation of AL/B4C nanocomposite powders: Experimental and numerical analysis

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In this paper, densification behavior of nanocomposite powders of Al/15 vol% B4C was investigated during the single action compaction. The Drucker/Prager Cap model was applied to determine compaction be-havior and density distribution of Al/B4C composite and nanocomposite powders. Experimental data and parameters in the model were obtained from compression tests with various loading conditions. Finite element results from the models were com-pared with experimental data for densifica-tion behavior of mixture of powders. Re-sults of the density distribution obtained with the model show a good agreement with the experimental data. The experimental data and model show that density distribution of Al/15%volB4C nanocomposite powders is more uniform compared to the composite ones.

Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Numerical modelling on nano structured coating in suspension plasma spray

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Suspension plasma spray is a promising technique for nano-structured coatings and nano-powder synthesis where nano-particles are injected into the plasma jet with the help of liquid precursors. When the particles fly through the plasma flame, their mass, momentum and energy will dramatically change due to the interaction with the flame. A comprehensive model was developed to investigate the suspension spraying in the radio frequency inductively coupled plasma torch. The model is based on hybrid Eulerian/Lagrangian coordinate system to illustrate the suspension behavior, such as suspension droplets collision, heating and evaporation; nano or agglomerate particles heating, melting and evaporation. Special considerations are directed to the suspension droplets collision, non-continuum effects and the influence of evaporation on heat transfer. After validation with experimental data, the comprehensive particle model is used to predict the trajectory, velocity, temperature and size of the in-flight nano- or agglomerate particles. A parametric analysis has been performed to find the way of controlling the operating conditions for desirable final particle status. The parameters that have a significant influence on the spray process are identified. The relationship between the predicted height of droplet complete evaporation and the droplet initial diameter is deduced. Finally, results also calculate the critical size of an ethanol droplet suspended with zirconia particles, which will be completely vaporized under present conditions.

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Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Biological study of some first series transition metal complexes with adenine ligand

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Adenine complexes were prepared with some of the first series transition metals in a stoichiometric ratio of 1:2 (Mn+: L), where Mn^{+} = Mn^{2+}, Fe^{3+}, Co^{2+}, Ni^{2+}, Cu^{2+}, Zn^{2+}, and Cd^{2+} ions. The complexes were characterized by the physicochemical and spectroscopic techniques as electric conductivity, metal contents, IR, UV–visible, and molar conductance techniques. The stoichiometric ratios of the synthesized complexes were confirmed by using molar ratio method. The dissociation constant of adenine ligand was determined spectrophotometrically. Solvent effect on the electronic spectra of the adenine ligand was examined using solvents with different polarities. The biological activity of adenine ligand and its metal complexes were tested *in vitro* against some selected species of fungi and bacteria. The results showed a satisfactory spectrum against the tested organisms.

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Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Biosynthesis of copper nanoparticles by using *Aloe barbadensis* leaf extracts and study of application in Congo red (acid red 28) dye removal

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Development of green nanotechnology is generating interest of researchers toward eco-friendly biosynthesis of nanoparticles. In this study, biosynthesis of stable copper nanoparticles was done using *Aloe barbadensis* leaf extract. First of all, we prepared leaf extract of *Aloe barbadensis* in deionized water. This extract added to 1 mmol of copper sulfate solution and observed the change in color of the solution from colorless to dark brown colored solution. The present study tracing of an object is a green synthesis of copper nanoparticles by the interaction of leaf extract and copper salt and its dye removal efficiency. Copper oxide nanoparticles in this study examined the efficient removal of Congo red CR dye. The effect of variables like concentration, time, PH, adsorbent dosage also examined in this present study. This was noted that maximum PH 3, the concentration of nanoparticles 1 mg, maximum time 120 minute was optimum condition for dye removal. Biosynthesis of nanoparticle put forward a cost-free and environmentally suitable method of nanoparticle synthesis. The characterization of copper oxide nanoparticles like X-ray diffraction and SEM analysis showed that average particle size calculated was 40 nm. The shape of the copper nanoparticles was spherical and cubic and their range of grain was 80-120 nm. EDX of synthesized nanoparticles showed copper 38%. UV spectrophotometer analysis confirms peak of the copper nanoparticles between 200-600 nm.

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Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Next generation C_{60} enabled antibiotics

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The objective of my research is to design, synthesize and tailor a nanoparticle-antibiotic conjugate capable of a multi-targeted approach to multi drug resistant (MDR) pathogenic bacterial infections, such as C_{60}–Ampicillin. Post-synthesis the mechanisms of interaction between the conjugate and the bacteria will be elucidated, to allow for refinement and optimisation of the multi-targeted approach. This work will develop new methodologies and standards for testing the antimicrobial properties of novel nanomaterials. Current antimicrobial agents such as ampicillin and streptomycin which have worked effectively for decades are no longer a viable way of treating bacterial infections due to the resistance they are continuously developing and passing onto the next generation. It is imperative that a new strategy is developed to deal with this treat as a current World Health Organization study in 2014 estimated 10 million deaths per year worldwide with this projection only to increase. Bacteria have developed resistance to ampicillin via efflux pumps, reduced affinity, enzyme degradation and target alteration. It is hoped these resistive traits can be attacked by the C_{60} –AMP complex which offered a reduced affect when tested against clinical strains of *E.coli*. The complex has been characterized extensively with, DLS, Zeta potential, UV/Vis spectra, IR spectra and Raman.

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Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Electroanalytical detection of heavy metals using metallophthalocyanine and silica coated iron oxide composites

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The monitoring of heavy metal ions particularly in water is important in safeguarding the environment and humans from the toxic effects these metal ions pose. This work describes the synthesis, characterization and electrocatalytic properties of silica coated iron oxide nanoparticles (Si-NP) in the presence of cobalt or iron phthalocyanines (MPc) for heavy metal (HM) detection. TEM, XRD, XPS and VSM confirmed the successful synthesis of Si-NP with an average diameter of 12.07 nm. The electrochemical sensing properties of MPc/Si-NP modified glassy carbon electrodes (GCE) were assessed for HM detection. Differential pulse anodic stripping voltammetry (DPASV) studies indicated detection limits that compared positively with literature. The FePc/Si-NP composite showed the lowest detection limits of 3.66 µg L-1, 11.56 µg L-1, 2.28 µg L-1, 4.54 µg L-1 for arsenic (As), cadmium (Cd), mercury (Hg) and lead (Pb), respectively. Both composites displayed reproducible signals for the simultaneous detection of the HMs. These composites offer a cheap and simplistic sensing alternative for HM analysis.

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Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Fluorescent and T1 MRI active multilayer nanoparticle for imaging and targeting cellular delivery

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Multifunctional plasmonic nanostructures have enormous potential in the treatment of solid tumors, however, tracking particles with drug cargo and triggering the release of the cargo in mapped tumors is still impossible. To overcome this challenge we have developed an MRI and fluorescent active nanostructure nanomatryoshka. This new nanostructure with IR plasmonic signatures is composed of a 50 nm Au core surrounded by dye molecules and Gd(III)-DOTA chelate doped SiO2 inner-shell and an outer Au shell. The experimental results demonstrates an enhanced T1 relaxation (r1~24 mM-1 s-1 at 4.7 T) compared to the clinical Gd(III)-DOTA chelating agents (r1~4 mM-1 s-1). Further, this design preserves the fluorescence signal (65%) after 24 hours of exposure, leading to enahanced fluorescence photostability (23x). This dual-imaging functionality nanosystem increases MRI sensitivity by concentrating Gd(III) ions into the Gd-NMs, reduces the potential toxicity of Gd(III) ions and dye molecules by preventing their release *in vivo* through the outer Au shell protection, and the terminal gold layer surface can then be functionalized to increase cellular uptake, circulation time, or thermal drug-release properties.

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Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Microemulsion routes to nanomaterials of controlled size and toxicity

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The extent to which NPs are bound onto or into macro matrices by say chemical glues [1] affects their availability and health-environmental impact. The toxicity of NPs has an important impact on human health and the environment. This can from their high surface: volume ratio (i.e. their particle size), but also their morphology, degree of aggregation and concentration [2], and because of all these they interact uniquely with their surrounding environment. Often their toxicity increases as their size decreases, possibly due to their (i) ease of penetration of cell walls, (ii) higher solubility and vapour pressure (via the Kelvin equation), (iii) higher reactivity with larger number of defects and lower number of nearest neighbours (N) and (iv) low stability metastable structures. Their higher toxicity in seen in reference [3]. It ought to relate to particle size effects seen in other spheres of chemistry, e.g. catalysis of structure -sensitive and –insensitive reactions over small metal particles noted at Brunel in the 1980s [1]. For example growth of Ru NPs can at intermediate sizes produce B5-sites. Fractal analysis [4]; surface geometries can overshadow surface chemistry. Fractal analysis is a tool for investigating these complex structures. If the surface has n sites of area σ then the surface area A=nσ. Here we consider the opportunities provided by non-ionic surfactant (NIS)-stabilized water-in-oil microemulsions to produce designer nanoparticles of metals, oxides, perovskites and nanocomposites. In this area France has a long heritage [5].

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Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Confined nanoscale geometries to enhance sensitivity of plasmonic immunoassays

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Sensitive transduction of bio-molecular binding events on chip carries profound implications to the outcome of a range of biological sensors. This includes biosensors that address both research as well as diagnostic questions of clinical relevance, e.g. profiling of biomarkers, protein expression analysis, drug or toxicity screening and drug-efficacy monitoring. Nanostructured biosensors constitute a promising advance in this direction owing to their ability in catering to better sensitivity, response times, and miniaturization. Plasmonic sensors are particularly interesting among nano-biosensors as they exploit light matter interactions in the nanoscale to transduce bio-recognition events with high sensitivity and miniaturized measurement footprints. Examples of plasmonic sensors include localized surface plasmon resonance spectroscopy (LSPR), surface enhanced Raman spectroscopy (SERS) and metal-enhanced fluorescence (MEF). The performance of the plasmonic sensors critically relies on ability to engineer nanoscale geometric attributes at length scales that typically overlap with the size of small proteins. Such geometries invariably introduce constraints on the molecular binding response, thus altering the interaction outcomes, viz. density and kinetics of adsorption, molecular orientations, in a manner that would impact the resulting optical response. A careful engineering of the nanoscale geometries can simultaneously take advantage of EM field enhancements together with molecular interaction within nanoscale geometries. To this end, this project aims at an engineered nanoscale interface with geometry tailored to simultaneously favour molecular adsorption and plasmonic enhancements for application to plasmonic sensors based on surface-enhanced Raman and fluorescence spectroscopies.

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Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Engineering gyroid-structured functional materials via templates discovered in nature and in the lab

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In search of optimal structure for functional materials fabrication, the gyroid (G) structure has emerged as a promising subject of widespread research due to its distinct symmetry, 3D interconnected networks and inherent chiral helixes. In the past two decades, researchers have made great progress in fabricating G-structured functional materials (GSFMs) based on G templates discovered both in nature and in the lab. The GSFMs demonstrate extraordinary resonance when interacting with light and matter. The superior properties of GSFMs can be divided into two categories based on the dominant structural properties of G structure, namely dramatic optical performances dominated by the short-range symmetry and well-defined texture, and effective matter transport subjected to the long-range 3D interconnection and high integrity. Since most of the G systems are made up of organic components with limited applications, research interests focus on combining knowledge about these organic G systems with the functionality of solid-state materials to generate novel hierarchical and multifunctional hybrid materials. The choosing of proper G templates is a key step determining the successful fabrication of GSFMs. Therefore, in this review, we will firstly give a detailed classification of G templates available for fabrication of functional materials. And then we will put an emphasis on the state-of-the-art achievements of optical applications of GSFMs originated from efficient light-matter interaction, including photonic band gap materials, chiral materials and plasmonic materials in State Key Lab of Metal Matrix Composites, Shanghai Jiao Tong University in the past five years. Finally, some major challenges that may hinder the final applications of GSFMS and possible solutions will be thoroughly discussed.

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Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Sub-oxide passivation of silicon nanoparticles produced by mechanical attrition

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The presence of native oxide on the surface of silicon nanoparticles is renowned for constraining charge transport on the surfaces. Studies carried out using scanning electron microscopy (SEM) shows that the particles in the printed silicon network have a wide range of shapes and sizes. High-resolution transmission electron microscopy reveals that the particle surfaces are dominated by the (111)- and (100)-oriented planes which stabilizes against further oxidation of the particles. X-ray absorption spectroscopy (XANES) and X-ray photoelectron spectroscopy (XPS) measurements at the O 1s-edge have been utilized to study the oxidation and local atomic structure of printed layers of silicon nanoparticles which were milled for different times. XANES results reveal the presence of the +4 (SiO_2) oxidation state which tends towards the +2 (SiO) state for higher milling times. Si 2p XPS results indicate that the surfaces of the silicon nanoparticles in the printed layers are only partially oxidized and that all three sub-oxide, +1 (Si_2O), +2 (SiO) and +3 (Si_2O_3), states are present. The analysis of the change in the sub-oxide peaks of the silicon nanoparticles shows the dominance of the +4 state only for lower milling times.

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Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Nano tattoos for medical diagnostic applications

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Nanotechnology is a new and innovative field that measures and manipulates material at the level of one to one hundred nanometers, each of which is one billionth of a meter. Combining this with biology, the physical sciences, and engineering opens an entire new realm of technology called nanomedicine. Although there are currently methods for treating those with diabetes, the approach of testing blood glucose levels and administering insulin injections are not completely effective. Although nanomedicine for diabetes is relatively new and testing is still being done, scientists and engineers must continue to devote time and resources to progress the development of glucose monitoring systems. With the use of nanotechnology, nanoparticles provide a means to measure glucose levels continuously instead of only at specific times. This is very important for diabetics; instead of checking their sugar levels only once or twice a day, they will have constant knowledge as to where their sugar levels are located. The smart tattoo can provide the solution to this ongoing problem. If smart tattoos become commercially available for insulin-dependent diabetics, it is vital that it is a safe and reliable means for glucose monitoring. In order for this to happen, engineers and scientists must undergo comprehensive research, along with a set of guidelines to abide by in order to ensure integrity and honesty. The current paper explores the feasibility of smart tattoos for future medical diagnosis purpose.

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Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

UV spectro photometric method development & validation of duloxetine hydrochloride in bulk and solid dosage forms

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Duloxetine Hydrochloride: Duloxetine is a serotonin-nor epinephrine reuptake inhibitor. Effective for major depressive disorder and in generalized anxiety disorder. Drug analysis plays an important role in the estimation of the purity and quality of drugs, which are used in pharmaceutical formulations. In order to reduce the load and confusion to the patients, the disease is managed with several drugs in individual doses. Standard analytical procedures for these drugs or formulations may not be available, or the original methods are cumbersome, time consuming. Hence, it is important to develop methods such that, they are widely available and in common use in control laboratories.

Linearity: The linearity study was carried out for DLX in zero order spectrum at the above said wavelength. The calibration curves were obtained by plotting absorbance versus concentration of the standard solution

Accuracy: Accuracy of the method was established by recovery studies by external standard addition method. The known amount of standard was added at three different levels to the preanalysed sample solution, each determination was performed in replicate. The amount recovered and the percentage recovered was calculated.

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