Nanometer-scale Science and Technology
Room Hall D - Session NS-TuP

Nanometer-scale Science & Technology Poster Session

NS-TuP1 tPA Loaded Fe_3O_4 Nanorods to Enhance and Target Stroke Treatment, ***Weijie Huang***, University of Georgia; *J.N. Hu, S.W. Huang, K.L. Jin,* University of North Texas; *Y.P. Zhao,* University of Georgia

Stroke remains the 4th leading cause of death in United States and the No. 1 cause of adult disability among the world. Current stroke treatment with tissue plasminogen activator (tPA) therapy faces a lot of challenges due to its side effect. For example, the administration time window of tPA to lyse clots is within the first 3 hours after the initial onset of stroke since the risk of tPA-related hemorrhage is significantly increased after that. Besides this, the traditional tPA therapy also fails to lyse the clot and recanalize the middle cerebral artery in about half cases.

We propose an active drug loaded Fe_3O_4 nanorod strategy to improve the stroke treatment therapy. Fe_3O_4 nanorods were fabricated by oblique angle deposition technique and loaded with tPA using glutaraldehyde as the cross-linker. *In-vitro* study showed that the tPA loaded nanorods could achieve a mass loading ratio (drug mass over rod mass) of 6% and a release time of 30 min. Once the nanorods were immersed in liquid and stimulated by an external rotating magnetic field, about 11% of loaded tPA was released and the thrombolysis efficiency was increased by about 40%. Such an enhancement is due to the increased tPA local concentration and the enhanced mass transport in the fluid, which could help more tPA be delivered into the clot. Such a strategy has been demonstrated using *in vitro* blood clot experiments. We believe that this strategy could improve thrombolysis and recanalization rates, reduce the risk of tPA-mediated hemorrhage, and maybe applied for other disease treatment.

NS-TuP2 Gelatin Nanoparticle Encapsulation of Anti-Parasitic Compound and Characterization for Treatment of Leishmaniasis Disease, ***Carlos Serna***, *A. Ornleas, E. Iniguez, K. Michael, R. Maldonado, T. Boland,* The University of Texas at El Paso

Leishmania major is azoonotic flagellate protozoan transmitted to humans and other mammals through phlebotomine female sand flies. *L. major* is mainly responsible for causing cutaneous leishmaniasis (CL) in endemic areas of the Old World, with about 1 million new infections each year [1]. The Mannich base compound *1-acetyl-3,5-dibenzylidene-4-piperidone(**2**)* has been found to have effective anti-parasitic properties, but lacks solubility making it difficult to deliver using standard methods. In this study, we synthesized gelatin nanoparticles (GNP) as carriers for the treatment molecule and demonstrate an effective method of delivering anti-parasitic treatment enhancing drug delivery and reducing toxicity in treatment.

Materials and Methods: *1-acetyl-3,5-dibenzylidene-4-piperidone(**2**)* was synthesized by dissolving *3,5-dibenzylidene-4-piperidone(**1**)*in a mixture of 10% acetic anhydride and 5% diisopropylethylamine in dichloromethane while stirring at room temperature. The Ofokansi et al. [2] two-step desolvation method was applied to produce GNP. To maximize the encapsulation yield of the compound, the preparation method was further modified by limiting the drop-wise cross-linking agent (glutaraldehyde) rate to 30 min and replacing DI water with phosphate buffer saline (PBS) for higher pH stability. Unloaded GNP sizes were determined using a particle size analyzer (Nanosight) in order to test for GNP swelling in varying pH levels. UV visible spectroscopy was used to identify the release rate and total concentration of the compound encapsulated. A viability and cytotoxicity assay was conducted in the testing of loaded and unloaded GNP.

Results and Discussion: The mode values of size distributions using PBS pH 5, 7,and 9 in the production of GNP were found to be 73 nm, 91 nm, and 121 nm respectively. Using UV visible spectroscopy, the concentration of compoundencapsulated by the GNP was found to be 4.01 µg/mL released over a time frame of 96 h in 2.4 g of GNP. A viability assay showed an EC50 value of 2.26 µM for *1-acetyl-3,5-dibenzylidene-4-piperidone(**2**)* in *L. major*; cytotoxicity for the murine intraperitoneal macrophages showed an IC50 value of 6.35 µM.

Conclusions: GNP characterization showed an increase in size with respect to increasing pH in PBS used in the production process; the swelling initiated by exposing GNP produced at pH 5 to a PBS solution of pH 8 showed a release rate of 1 µg/mL per day for 4 days. Viability assays showed the GNP to be effective against *L. major* when encapsulated and non lethal when lacking a molecule payload.

References:

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NS-TuP4 Templated Annealing of Gold Nanowires formed by Directed Assembly on DNA Origami, ***Tyler Westover***, *M. Stoddard, B. Uptrey, R.F. Davis, J. Harb, A. Woolley,* Brigham Young University

The formation of gold nanowires using bottom up nanofabrication has resulted in wires of small dimension or high conductivity, but not both. We form nanowires on DNA origami through directed assembly of nanoparticles, electrochemical plating, or a combination of the two. These metal deposition processes result in non-ideal microstructure and correspondingly low conductivities. To remedy this we have sought to reduce the grain boundary density and surface roughness through annealing. However annealing causes the wires to coalesce into beads. We will present results on using polymer layers to maintain overall wire morphology during low temp (200° C) annealing.

NS-TuP5 Zinc Oxide Nanoprobe Spectroscopy for Sensing Trace Levels of Molecular Species in Solution, ***Andrew Cook***, Vanderbilt University; *C.S. Carson,* Fisk University; *J. DeCoste,* Edgewood Chemical Biological Center; *T.D. Giorgio,* Vanderbilt University; *R. Mu,* Fisk University

Surface-enhanced Raman spectroscopy (SERS) has great potential to revolutionize clinical diagnostics, yet is limited by an extreme intensity drop-off with distance from the sensing surface. For this reason, much research into SERS-based biosensing relies on chemical or physical adsorption of analytes to the active surface, which limits the types of analytes that can be detected, as well as detection sensitivity. Using the 3-dimensional closely packed architecture of zinc oxide nanowires decorated with silver nanoparticles, the enhancement drop-off can be effectively mitigated, allowing for adsorption-free biosensing. This greatly improves the viability of Raman spectroscopy as a biosensing technique. We demonstrate a significant SERS enhancement from silver nanoparticle-decorated zinc oxide nanoprobes to the Raman spectrum of crystal violet molecules in water, as a model system. More importantly, we demonstrate the detected SERS signal is from molecules un-adsorbed to the sensing surfaces via time-dependent Raman analysis. We also demonstrate growth of high quality zinc oxide nanowires and deposition of silver nanoparticles on the nanowire sides as a surface-enhanced sensing platform.

NS-TuP7 Effect of Deposition Temperature on the Formation of the SiO_2/ZnO/SiO_2 Heterostructure Deposited by Reactive RF Sputtering*, *R. Escobedo-Alcaraz, C. Atzin-Mondragon,* Cinvestav-IPN, Mexico; *A. Hernandez-Hernandez,* Escuela Superior de Apan, Mexico; *A. Garcia-Sotelo,* ***MiguelAngel Melendez-Lira***, Cinvestav-IPN, Mexico

The roughness associated with the sputtering deposition process has been employed to explore the possibility to produce ZnO nanoparticles embedded within a silicon oxide matrix on soda-lime glass and p-silicon substrates. Silicon dioxide and metallic Zn films were deposited employing silicon and zinc targets. An oxygen rich working plasma was employed. Oxygen content of the working plasma was modulated through argon partial pressure. A sequential deposition of SiO_2/Zn/SiO_2 films was employed ; SiO_2 layer was produced at 400 °C while deposition temperature of Zn layer was changed between 100 and 500 °C. Results of the chemical, structural and electronic properties are presesented. The Results indicated the successful production of ZnO with properties depending on deposition temperature. X-ray diffraction characterization do not shown the presence of metallic zinc. Secondary ion mass spectroscopy shown an interdifussion of zinc toward the SiO_2 matrix. TEM micrographs indicated the presence of ZnO nanoparticles. XPS corroborates the ZnO formation under specific growth parameters. Photoluminescence emission at room temperature for samples grown on silicon substrates was not observed. Electrical transport properties are discussed on terms of deposition parameters.

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NS-TuP8 Design of High Performance Compact Plasmonic Optical Devices Based on Low Loss Silicon Hybrid Dielectric Loaded Plasmonic Waveguides, ***Cheng-Hung Hsieh***, *C.M. Kuo,* National Tsing Hua University*; M.J. Huang,* Naitoal Tsing Hua University*; R.J. Sun,* National Tsing Hua University*; K.C. Leou,* National Tsing Hua University, Taiwan, Republic of China

Here we present the design of several plasmonic optical devices which have gained a great deal of attention recently for potential application in nano photonic circuits. A unique ultra low loss surface plasmon polariton (SPP) waveguide, top metal silicon (Si) hybrid dielectric-loaded plasmonic waveguide (TM-SiHDLW), was first designed. The waveguide adopted a top metal stripe structure for easier process integration with conventional micro fabrications and a thick (200 nm) metal stripe was found to yield optimal performance due to reduced Ohmic loss in conductor around the stripe edge/corner. Moreover, a relatively thick (150 nm) dielectric spacer between the Si ridge and the metal stripe was employed to achieve both long propagation length and good field confinement. Results from numerical simulation show that a long propagation length of 350 μm and a small mode area of 0.03 m^2 are obtained. The TM-SiHDLW structure was also adopted for design of several compact high performance plasmonic optical devices, including a directional coupler, a disk resonator and an switch. The directional coupler adopted a coupled waveguide structure. A coupling length as low as 2.95 μm, only ~ 0.85% of the propagation length, was obtained. The second device is a disk resonator operating at the low loss TE mode. Simulation results demonstrate that a quality factor as high as 2000 can be achieved at a size much smaller than that of a conventional ring resonator. Another plasmonic optical device we have explored was an electro-optical (E-O) switch where an organic E-O material was chosen for low switching voltage along with having a better compatibility with conventional microfabrication processes. The switch we proposed employed a coupled waveguide structure configured in a way that the optical wave can be switched between to two waveguides, depending on the voltage applied on the switch electrodes. All these SPP waveguides and devices were designed to operate at the standard 1550 nm wavelength.

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References

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NS-TuP9 Carbon Nanotube Based Digital X-ray Tube for a Very Short X-ray Pulse with High Dose Rates, ***Jun-Tae Kang***, *J.W. Jeong, J.W. Kim, Y.C. Choi, S.H. Kim, H. Jeon, S. Park, M.S. Shin, J.H. Yeon, E. Go, J.W. Lee, Y.H. Song,* Electronics and Telecommunications Research Institute (ETRI), Republic of Korea

Carbon nanotube (CNT) field emitters are being considered as a promising electron source of x-ray tube, which is expected to overcome the limitations of conventional thermionic tubes. The thermionic x-ray tube has been fabricated using a hot cathode, causing analog behaviors like slow response time. On the other hand, the field-emission x-ray tube with CNT emitters can be digitally addressed, which makes it possible to give a very short exposure time. The high x-ray dose rate in a very short exposure time is very important for achieving clear x-ray images.

We have successfully fabricated a digital x-ray tube with CNT field emitters for medical applications. The x-ray tube sealed in a vacuum level of below 5×10^{-6} Torr consists of a CNT field emission gun and a rotating anode made of W/Re target on a Mo block. The field emission current over 100 mA is attained by the gate bias of several kV and is fast modulated through an active-current control at the cathode node, showing a very short x-ray pulse under submicron seconds at a high dose rate. The developed x-ray tube is expected to be used in the advanced diagnostic imaging system with a very short exposure time and high x-ray dose.

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