Tuesday Afternoon Poster Sessions, December 4, 2018

Nanomaterials
Room Naupaka Salon 1-3 - Session NM-TuP

Nanomaterials Poster Session I

Moderator: Shintaro Fujii, Tokyo Institute of Technology

NM-TuP1 alginate based Nanocomposite for Microencapsulation of Probiotic: Effect of Cellulose Nanocrystal (CNC) and Lecithin, *Monique Lacroix,* INRS-Institut Armand-Frappier, Canada

Lactobacillus rhamnosus ATCC 9595 were encapsulated in alginate-CNC-lecithin microbeads for the production of nutraceutical microcapsules. The concentration of CNC and lecithin in alginate microbeads was optimized by monitoring the viability of *L. rhamnosus* after stabilization of the microbeads by freeze-drying. Results showed that alginate microbeads (AC-0) reduced by 0.95 log CFU/g whereas addition of 13 wt% CNC in alginate microbeads (AC-3) reduced ($P > 0.05$) by 0.01 log CFU/g of bacterial viability after freeze drying. Incorporation of 2 wt% lecithin in alginate-CNC microbeads (ACL-1) also revealed a protective effect during free drying same as alginate-CNC microbeads (AC-3). The compression strength of the freeze-dried ACL-1 microbeads improved 40% compared to alginate microbead alone. Swelling studies revealed that addition of CNC and lecithin in alginate microbead decreased (around 47%) the gastric fluid absorption but increased the dissolution time by 20 min compared to alginate microbeads (A-0). During complete transition through the gastric passage, the viability of *L. rhamnosus* in dried ACL-1 microbeads was 52% higher as compared to *L. rhamnosus* encapsulated in A-0 based beads. The viability of *L. rhamnosus* was also evaluated during storage at 25 and 4°C. It was found that at 25 and 4°C storage conditions, the viability of *L. rhamnosus* encapsulated in ACL-1 microbeads decreased by 1.23 and 1.08 log respectively, whereas the encapsulation with A-0 microbeads exhibited a 3.17 and 1.93 log reduction respectively.

NM-TuP2 In-situ Low Energy Electron Microscopy at Near Ambient Pressures, *Thomas Schulmeyer,* SPECS-TII, Inc.

Low-energy electron microscopy (LEEM) is a spectromicroscopy technique, which allows the study of dynamic processes at surfaces and interfaces, such as thin-film growth, surface reactions, and phase transitions. With the FE-LEEM P90 from SPECS, which is based on the instrument design by Rudolf Tromp from IBM, lateral and energy resolution of below 5 nm and 250 meV, respectively, can be achieved. Depending on the excitation source and the settings on the instrument a variety of different imaging modes are possible: mirror electron microscopy, low energy electron diffraction (LEED), phase contrast imaging, reflectivity contrast, dark field imaging and bright field imaging, as well as photoelectron emission microscopy and spectroscopy. As a new development the technical capabilities of LEEM and PEEM have been extended towards near ambient conditions by developing a special objective lens concept and sample chamber geometry. This enables the analysis of materials and devices under near ambient conditions and even in situ during operation. For this a Laser heater allows for sample temperatures up to 800°C during the measurements. The technical realization will be presented in detail. Furthermore experimental results will be shown on Graphene, Silicon under Nitrogen atmosphere. First results from real surface reactions will be discussed.

NM-TuP8 Surface Nanostructures Composed of Thiolated Cyclodextrin/Au and Fe Species: Gas- and Liquid-Phase Preparation, *S. Kotorova,* Institute of Nuclear and Physical Engineering, FEI STU, Slovakia; *Monika Jerigova,* Comenius University, Bratislava, Slovakia; *D. Lorenc,* International laser center, Bratislava, Slovakia; *M. Prochazka,* Polymer Institute, Slovak Academy of Sciences, Bratislava, Slovakia; *D. Velic,* Comenius University, Bratislava, Slovakia

Supramolecular surface nanostructures have application potential as functional devices. Studied system consists of a host molecule of monothiolated β-cyclodextrin chemically adsorbed on an Au surface through a S–Au bond (assigned as Au-S-CD) and of Fe species incorporated as the guest. Secondary-ion mass spectrometry (SIMS) is used to study the formation and composition of these surface supramolecular nanostructures.

The Fe species were prepared by pulsed laser ablation in water and thermal effusion in vacuum. Using laser ablation in water, the solution of Fe species was dropped on Au-S-CD. The relevant mass peaks were observed at 1227 m/z, 1243 m/z and 1260 m/z and were assigned to $C_{42}H_{68}O_{34}SNa\text{-}Fe^+$, $C_{42}H_{68}O_{34}SKFe^+$, $C_{42}H_{68}O_{34}SNa\text{-}FeO^+$ and $C_{42}H_{68}O_{34}SK\text{-}FeO^+$,

which can be interpreted as supramolecular complexes with Fe as $C_{42}H_{68}O_{34}SNa\text{-}Fe$ and $C_{42}H_{68}O_{34}SK\text{-}Fe$ or adducts with FeO as $C_{42}H_{68}O_{34}SNa\text{-}FeO$ and $C_{42}H_{68}O_{34}SK\text{-}FeO$, respectively.The comparison of isotope distributions with the experimental data supported the presence of a supramolecular host–guest complex between Au-S-CD and the Fe species and an adduct between Au-S-CD and FeO. The Fe species were presumably the first product of the ablation, so the formation of a supramolecular CD-Fe complex was preferential. Presumably, the second product of the ablation were the FeO species. Thermal effusion, even with a cooled surface, was negative with respect to the complex observation, no mass peaks corresponding to supramolecular complexes were observed. Nevertheless, a glucopyranose unit of the CD-S molecule and a variety of molecular fragments corresponding to CD-S associated with Fe and FeO were observed. One can assume that supramolecular complex formation is in this case also dependent on the surface diffusion of the Fe species. Since the surface diffusion of the Fe species at this low temperature might be minimized, the probability of complex formation might be close to zero.

References

[1] L. Rabara, M. Aranyosiova, D. Velic, Appl. Surf. Sci. 2011, 6, 1886–1892.

[2] S. Halaszova, M. Jerigova, D. Lorenc, D. Velic, ChemPhysChem 2015, 10, 2110–2113.

NM-TuP9 Controlled Pore Arrangement of Silicon Nanoparticles Having Mesoporous Structure, *Taisuke Kuga, K. Sato,* Tokyo Denki University, Japan

In recent years, semiconductor nanoparticles (NPs) having mesopores have been applied in a wide range of environment, energy and medicine fields, such as sensors, rechargeable batteries and drug delivery systems. The NPs can produce inexpensively by using electrochemical etching. However, they are confronting some serious problems, such as complicated preparation techniques and low production yield of mesopores. Therefore, it is necessary to develop new synthesis approaches for realization of facile preparation of the NPs with mesopore structures and large-scale production of the mesopores. We have prepared silicon nanoparticles (SiNPs) with mesopore structures using an inexpensive chemical route with good productivity. In this presentation, we propose a new way to fabricate SiNPs with mesopore structures by simplified procedures based on a chemical approach, and investigate the size distribution, depth and density of the mesopores by scanning electron microscopy (SEM). The features of our synthesis technologies are to adopt the simplified synthesis system in which only commercially available SiNPs with mean diameter of approximately 100 nm and redox agent were used. The size, depth and density of the mesopores on the SiNP surfaces strongly depends on the redox reaction time. When the redox reaction time was 1 min, the shallow mesopores with mean size of approximately 24 nm were formed on the SiNP surfaces. As the redox reaction time increased from 1 min to 5 min, the depth of the mesopores deepened without change of mean size. SEM images of SiNPs with mesopores obtained by redox reaction time for 10 min were shown in Figure 1. The mesopores with mean size of approximately 29 nm were densely formed on the SiNP surfaces, and also their depths became increasingly deeper. Therefore, our suggested synthesis technologies can provide a new chemical route for high production yield of mesopores.

NM-TuP10 Nanobiosensor Comprising Conductive Polymer Enclosed with Polymer Vesicles for Selective Detection of Influenza A Virus, *Geunseon Park,* Yonsei University, Republic of Korea; *H.O. Kim,* Korea University, Republic of Korea; *J.-W. Lim, C. Park, S. Haam,* Yonsei University, Republic of Korea

Nanobiosensor has been selected as a method for detecting wide range of pathogens to prevent pandemic emergence. As one of promising platform, conductive polymer based nanobiosensor has a distinct advantage in the way that its ability to sensitive and rapid detection. In this study, we designed a detection system which is conductive poly aniline based on polymersome conjugated with peptide for specific recognition of influenza A virus. We synthesized poly aniline polymerized within a polymersome consisting of methoxy polyethylene glycol-block- polyphenylalanin co-polymer (mPEG-b-pPhe). Then we conjugated the polymersome with peptide binding to hemagglutinin located on the surface of influenza virus. In the presence of Influenza virus, the nanoparitlce aggregated with the virus, exposing absorption wave length change. These results indicate that this nanobiosensor could be a potential candidate in terms of detecting influenza virus.

NM-TuP11 Efficient Antiviral Delivery Polymersomes by Optimization of Surface Density of Cell-targeting Groups for Virus Treatment, *Chaewon Park, H. Chun,* Yonsei University, Republic of Korea*; M. Yeom, H.-O. Kim,* Korea University, Republic of Korea*; J.-W. Lim,* Yonsei University, Republic of Korea*; W. Na,* Korea University, Republic of Korea*; G. Park,* Yonsei University, Republic of Korea*; A. Kang,* Korea University, Republic of Korea*; D. Yun,* Yonsei University, Republic of Korea*; J. Kim,* Yonsei University, Republic of Korea*; D. Song,* Korea University, Republic of Korea*; S. Haam,* Yonsei University, Republic of Korea

Influenza A virus (IAV), which causes one of the most contagious diseases is a global health concern, and is responsible for seasonal epidemics and pandemics. Despite laudable advances in antiviral agents and drugs, the vast majority of them have shown limited efficacy due to non-specificity and low viability in physiological or endosomal environment, especially in the case of intracellular drug. A nano platform, consisting of phenylboronic acid (PBA) pendant group polymer which has sialic acid-targeting property, gained greater access to the intracellular space transporting antivirals within the host cell. Amphiphilic copolymers made of pPhe-b-mPEG-PBA formed polymersomes which encapsulated hydrophilic antiviral agents in the core and hydrophobic drugs in the exterior layer. Combination of antiviral drug delivery using amphiphilic nanocarrier and cell-targeting functional group gives a better chance to improve transfection and intracellular distribution efficiency of therapeutic substances.

NM-TuP12 Photovoltaic Performance of Inorganic/Organic Hybrid Solar Cells using Boron-doped Silicon Nanoparticles, *Kuniaki Furuya, K. Sato,* Tokyo Denki University, Japan

Solar cells using silicon nanoparticles (SiNPs) have attracted attention as one of highly-efficient cells because they not only widen the absorption bands of solar light but also enable the light harvesting via excitonic energy transfer [1]. In order to enhance the transfer efficiency of photogenerated charge carriers between the SiNPs region, we have fabricated boron (B)-doped p-type SiNPs of single nanometer in size by combining thermal diffusion at high temperature with redox reaction of the surface regions of the Si powders (100 nm in size) in etchant containing hydrofluoric acid/nitric acid. Additionally, we have also prepared the inorganic/organic hybrid solar cells consisting of the B-doped p-type SiNPs and poly(3,4-ethylenedioxythiophene):poly(styrenesulfonate) (PEDOT:PSS) so as to reduce the production cost. In such hybrid solar cells, the arrangement of the B-doped p-type SiNPs and PEDOT:PSS in the active layer is critical to improve the power conversion efficiency (PCE). In this presentation, we focus on the position of the B-doped p-type SiNPs, such as the stacking structures consisting of n-type Si substrate/blend layer of B-doped p-type SiNPs and PEDOT:PSS and the stacking structures consisting of n-type Si substrate/B-doped p-type SiNPs/PEDOT:PSS, and discuss the photovoltaic performance of these inorganic/organic hybrid solar cells. The *J-V* characteristics of the hybrid solar cells consisting of n-type Si substrate/blend layer of B-doped p-type SiNPs/PEDOT:PSS (cell 1) and n-type Si substrate/B-doped p-type SiNPs/PEDOT:PSS (cell 2) were shown in Figure 1. The photovoltaic performance of these hybrid solar cells strongly depends on the arrangement of the stacking structures. The cell 1 constructed from the blend layer of B-doped p-type SiNPs/PEDOT:PSS obtained PCE of 3.85% with open circuit voltage (V_{oc}) of 0.36 V, short circuit current density (J_{sc}) of 26.5 mA/cm^2 and fill factor (FF) of 0.40. The value of the PCE increased to 5.27% for the cell 2 stacked individually the B-doped p-type SiNPs and the PEDOT:PSS, showing the V_{oc} of 0.34 V, J_{sc} of 29.6 mA/cm^2 and FF of 0.52. This result demonstrates that the control of arrangement of B-doped p-type SiNPs is beneficial for obtaining the higher PCE because of the efficient transport of the charge carriers between the NPs region.

Reference

[1]T. Subramani, J. Chen, Y. Sun, W. Jevasuwan, and N. Fukata, Nano Energy, 35, 154-160, (2017).

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