

CUNY NANO DAY

THURSDAY JUNE 15
CUNY ASRC



Full program with speakers abstracts

12.00 pm

Welcome Remarks

Rein V. Ulijn

CUNY Advanced Science Research Center & Hunter College

12.05 pm

Multimodal in vivo evaluation of a surface-converting nanoparticle platform

Francois Fay*

York College

Active targeting of nanoparticles through surface functionalization with ligands such as antibodies, peptides or nucleic acids has shown significant advantages in preclinical cancer nanotherapy studies. However, in the bloodstream, targeting moieties present on the nanoparticle surface may cause elevated recognition by the mononuclear phagocyte system and thereby compromise nanoparticle pharmacokinetic characteristics. To overcome this limitation, we have developed a new lipid-PLGA nanoparticle platform, which is decorated with RGD peptides but is shielded by a matrix metalloproteinase-2 (MMP2) cleavable polyethylene glycol (PEG) coating to prevent NP/cell interaction in the bloodstream. Once the nanoparticles accumulate within the tumor microenvironment and are exposed to MMP2, the enzymatic cleavage of the PEG polymers leads to the surface exposure of the targeting peptides.

Using an in vivo multimodal imaging strategy involving nuclear, magnetic resonance and optical imaging approaches in an orthotopic murine breast cancer model, we observed that this new enzyme specific surface-converting coating strategy led to prolonged blood circulation and passive accumulation of the nanoparticles in the rim of the tumors. Subsequent ex vivo flow cytometry measurements revealed that our surface-converting nanoparticles exhibited higher tumor cells targeting efficiency compare to control nanoparticles. These results demonstrate that our surface-converting coating ensures a high cell-targeting specificity without compromising favorable nanoparticle pharmacokinetics. We believe that this highly modular strategy can easily be tailored for other types of cancer or inflammatory conditions.

12.35 pm

Function and Polydispersity Optimization in the Liquid Phase Synthesis of Amphipathic, Self-Assembling Polypeptides

Matthew B. Kubiľius* & Raymond S. Tu

The City College of New York

One of the main limitations to modern peptide synthesis is the relatively high cost of the products relative to the reagents. Liquid-phase synthesis offers the possibility of forming low-cost polypeptides, but the condensation reaction comes with the potential for high polydispersities when forming high molecular weight polypeptides. To overcome this, we engineered and synthesized amino acid dimers that are both amphipathic and water-soluble. When polymerized, these dimers form repeat sequences in polypeptides with alternating hydrophilic/hydrophobic side groups, and, therefore, the polypeptides are designed to develop a periodicity conducive to the formation of β -sheets. We then decrease polydispersity of the growing polypeptide chains by modifying the kinetics of growth through transport-

limited chain elongation. Our experiments show that in the absence of a surfactant interface, standard bulk-phase condensation polymerization occurs. In contrast, in the presence of surfactant, the amphipathic character of the polypeptides results in the transport-limited elongation as the polypeptide partitions into micellar assemblies. This partitioning, taking place during chain growth, serves to narrow the polydispersity of our periodically-sequenced polypeptide. We quantify polypeptide size and assembly using multiangle light scattering and mass spectrometry and define evolving secondary structure using circular dichroism. Our results show that peptides grown in the presence of surfactant micelles show significantly enhanced self-assembly and narrowed polydispersity indices. We conclude that the transport-limited chain elongation polymerization in a surfactant-laden solution can be used in the manufacture of low-cost, self-assembling polypeptides. Finally, purified polypeptides were compressed on a Langmuir-Blodgett trough and imaged using Brewster angle microscopy, yielding surface pressure data characterizing the β -sheets on an air water interface.

12.55 pm

Peptide-porphyrin self-assembled nanostructures for artificial light harvesting in aqueous medium

Nadeesha Wijerathne,* Amrita Masurkar, Mohit Kumar, Ioannis Kymissis and Rein V. Ulijn
CUNY Advanced Science Research Center & Hunter College

In here, we demonstrate the formation of a nanofibrous Fmoc (9-Fluorenylmethyloxycarbonyl) protected di-peptide/porphyrin self-assembly in aqueous medium using enzyme catalyzed amide condensation to generate a light harvesting hydrogel. Bio-catalytic self-assembly via amide condensation is capable of generating self-healing nanostructures that form structurally optimized conformations enabling effective incorporation of porphyrin. A highly organized nano fiber network through minimal kinetic defects lead to good performance with the critical distance (10 Å) and preferred aggregation (J-aggregation) between porphyrin molecules by forming β -sheets locked together via π - π stacking interactions of Fmoc moieties. The resulting xerogel produces steady photocurrent under a robust broadband light source (425 nm-800 nm) when used as the photoactive layer in a thin film organic photodetector (OPD).

1.15 pm

The synthesis of platinum (II) – nuclear localization sequence peptide hybrid for nanoparticle development and anticancer therapy.

Marek Wlodarczyk*
Brooklyn College

Platinum (II) therapy is a well-established treatment of many malignancies, including ovarian cancer, and cisplatin is one of the most potent therapeutics. Fast aquation rate of cisplatin leads to its high systemic toxicity, which led to development other platinum based agents like carboplatin, with better toxicity profiles but lower effectiveness. Our work comprises the synthesis of new carboplatin-like Pt (II) complexes $C_{10}H_{21}N_5O_4Pt$ and $C_{10}H_{18}N_2O_4Pt$, with azide and alkyl functionalities that can be attached onto other supports to facilitate drug delivery. We formed Pt (II) peptide hybrid with SV40 large T antigen derived PKKKRKV peptide. The peptide used belongs to the nuclear localization sequence (NLS) that comprises the intrinsic cellular machinery of nuclear transport and was used to amplify the Pt (II) entry into the nucleus. The hybrid is highly soluble in water (<50 mg/ml), compared to cisplatin (2.5 mg/ml) and carboplatin (10 mg/ml). We found that Pt-NLS is highly efficacious in vitro, lowering the viability better than carboplatin in chemo naïve and in chemo resistant cancer cell lines. The methodology can be extended further to incorporate the Pt (II) complexes into polymeric nanoparticles.

1.35 pm

Poster Session with Lunch

Refreshments served in the ASRC Cafeteria

2.40 pm

Tunneling Current Measurement Scheme to Detect Majorana Zero Mode Induced Crossed Andreev Reflection

Lei Fang,* David Schmeltzer, Jian-Xin Zhu, Avadh Saxena
The City College of New York

We propose a scheme to detect the Majorana zero mode induced crossed Andreev reflection by measuring tunneling current directly. In this scheme a metallic ring structure is utilized to separate

electron and hole signals. Since the tunneling electron and the tunneling hole have different wave vectors, the conditions for them to be constructively coherent in the ring are different. We find that when we vary the magnetic flux threaded through the ring, we are able to observe positive and negative current peaks separately.

3.00 pm

A Structural Model of Nitro-Porphyrin Dyes based on Spectroscopy and Density Functional Theory

Christopher Farley*

Hunter College

Nitro-porphyrins are an important class of commercial dyes with a range of potential applications. The nitro group is known to dramatically affect the photophysics of the porphyrin, but there are few systematic investigations of the contributing factors. To address this deficiency, we present spectroscopic studies of a series of nitro-porphyrins, accompanied by density functional theory calculations to elucidate their structures. In particular, we explore how the position of the substituent affects the energy levels and nuclear geometry. As expected, nitro groups on the meso-phenyl rings cause small changes to the orbital energies by induction, while those at the β -pyrrole positions more strongly conjugate into the aromatic system. In addition, however, we find evidence that β -pyrrole nitro groups distort the porphyrin, creating two non-planar conformations with distinct properties. This unexpected result helps explain the anomalous photophysics of nitro-porphyrins reported throughout the literature, including inhomogeneous line broadening and biexponential fluorescence decay.

3.20 pm

Synthesis and characterization of Fe doped single-phase multiferroic

Frederick Pearsall*

The City College of New York

Discovery of new complex oxides that exhibit coupled ferromagnetic and ferroelectric properties is of great interest for the design of functional magnetoelectrics, in which research is driven by the long-term technological prospect of controlling ferromagnetic hysteresis with an electric field and vice versa. Multiferroics offer opportunities for sensors, 4-state logic (NVM), and spintronics. Single-phase coupled multiferroics are of theoretical interest due to the possibility of a quantum character in such coupling. BaMn₃Ti₄O_{14.25} (BMT-134) is a recently discovered single-phase multiferroic complex oxide exhibiting antiferromagnetic and ferroelectric behavior. In an attempt to exhort a room temperature ferroic order response, BMT-134 was doped with Fe at varying degrees. Using a chemical solution processing approach, three distinct variations of nanocrystals were synthesized; BaMn_{3-x}Fe_xTi₄O_{14.25} (BMFT) with $x = 1$, $x = 1.5$, $x = 2$. All variants were found to belong to the same hollandite crystal class as BMT-134 and Fe was shown to be incorporated into the crystals of each, proportional to the precursor ratios. Using EDS, elemental composition was determined qualitatively and iron content was corroborated with precursor amount. Mossbauer spectroscopy was used to determine the oxidation state of Fe and to probe its chemical environment. TEM and SEM techniques were used to determine size distribution and morphology of the nanoparticles and of their packing within pellets. The effective permittivity of pellet pressed capacitors was measured for each Fe variant.

3.40 pm

Closing remarks with Prize Winner Presentation

Rein V. Ulijn

CUNY Advanced Science Research Center & Hunter College