Yale Institute for Nanoscience and Quantum Engineering

Malone Engineering Center nano.yale.edu

Friday- November 30, 2018

12:00 -1:00 PM

BECTON SEMINAR ROOM

Light lunch will be served

Professor W. Mark Saltzman

Department of Biomedical and Dermatology, Yale University

" Bioadhesive Nanoparticles for Protection and Treatment of Human Skin"

Conventional sunscreen formulations are limited by post-application epicutaneous penetration that increases the risk of allergic dermatitis, cellular damage, and filter photodegradation upon ultraviolet radiation (UVR) exposure. We developed a new approach for UV protection that eliminates penetration into the skin: encapsulation of organic UV filters into bioadhesive nanoparticles (BNPs).[1] The BNPs are produced from a block copolymer of poly(lactic acid) and hyperbranched polyglycerol (PLA-HPG).[2] BNPs form stable aqueous suspensions, facilitate adherence to the stratum corneum without subsequent intra-epidermal penetration, and are water-resistant on skin yet can be removed via active towel drying. We show that BNP-based sunblock significantly reduces double-stranded DNA breaks in skin cells when compared to a commercial sunscreen formulation.[1] To develop these BNPs into a sunscreen that provides broad-spectrum UVR protection, we assessed the capacity of BNPs for co-incorporation of UV filters avobenzone (AVO) and octocrylene (OCR). The ratio of UV filters within nanoparticles was optimized for broad spectrum UVA and UVB absorbance, filter-filter stabilization upon UV irradiation, and maximum drug loading. In vitro water-resistance tests showed significant topical particle retention on synthetic skin at 85% over 3 hrs. In a pilot clinical study, protection against UVR-induced erythema of BNPs was found to be comparable to the FDA standard P2. Thus, sunscreen formulations utilizing BNP incorporation of combinations of organic filters may offer key safety and performance advantages.[6] In addition to protection against UV damage to skin, the PLA-HPG nanoparticles that we have developed may have advantages for other consumer and pharmaceutical applications.

Qiushi Guo

Department of Electrical Engineering, Yale University

"Room Temperature Mid-Infrared Light Detection Based on Graphene Plasmons"

Room temperature operation is mandatory for any optoelectronics technology for widespread applications. Unfortunately, room-temperature operation is still beyond reach for semiconductor photodetectors in the mid-infrared wavelength range of 8-14 µm. Graphene, a single layer of carbon atoms arranged in a hexagonal lattice, possesses a wealth of attractive properties in the mid-IR and THz frequency range. For instance, in stark contrast to noble metals, the mid-infrared plasmons in graphene can be sustained by a very small number of electrons that are strongly decoupled with phonons. This suggests that the absorbed mid-infrared radiation can lead to a fast and significant change of thermal energy of electrons. Moreover, the large in-plane thermal conductivity of graphene favors hot-carrier-assisted heat transport before dissipation into the surrounding media takes place. Despite these unique properties, the efficient electrical readout of hot-carrier generation by plasmons in graphene still remains an outstanding challenge at room temperature. In this talk, I will describe our strategies on addressing these challenges and a graphene mid-infrared detector which is capable of detecting thermalized carriers generated by the decay of mid-infrared plasmons. The device, with a sub-wavelength footprint, offers a high room-temperature external responsivity of 16 mA/W together with a measured noise-equivalent power (NEP) of 1.3 nW/$\sqrt{Hz}$. Importantly, the device is fabricated on large-scale CVD graphene that allows for scalable fabrication, representing an essential step toward the realization of on-chip mid-infrared detector array.

Host: Professor Corey O'Hern