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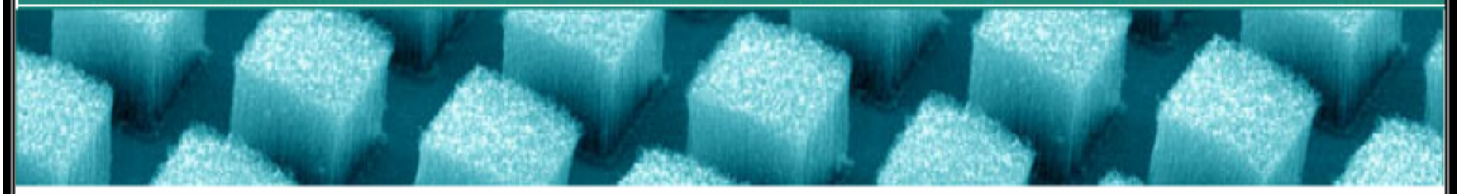

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"Porous Silicon Nanomaterials for Bioimaging and Nanomedicine"

PI: Dr. Michael Sailor

Tuesday, December 4, 2018
10:00a.m.
ASML Conference Center (SME 248)

Abstract: There is increased interest in porous silicon nanomaterials for biomedical applications due to their biodegradability, their biocompatibility, and their intrinsic photoluminescence. This thesis describes cargo loading chemistry, surface chemistry, molecularly targeted delivery and bioimaging applications using porous silicon nanomaterials. A single-step procedure to simultaneously load and protect a model siRNA therapeutic in porous silicon nanoparticles (pSiNPs) will be described. Exogenous calcium ions precipitate with locally generated silicic acid to form calcium silicate, which serves to encapsulate the siRNA payload in the porous silicon nanoparticles. The target gene knockdown efficiency in vitro and target tissue accumulation of delivered siRNA in vivo are demonstrated. A facile chemical modification of the surface of the hydroxylated silicon nanostructure will then be presented. The reaction, a ring-opening heterocyclic silane "click" reaction, is a rapid and efficient means to obtain high surface coverage while preserving the open pore structure and intrinsic photoluminescence of the original silicon nanostructure. This chemistry is sufficiently mild to maintain activity of payload proteins. Finally, two applications of pSiNPs relevant to in vivo imaging will be described. In the first example, the pSiNPs are targeted to tumor tissues in vivo using an iRGD peptide targeting probe, and the nanoparticles are imaged by two-photon microscopy. Superior photostability and low systemic toxicity is observed. The second in vivo imaging example discusses enhanced photoacoustic signals that can be obtained from indocyanine green (ICG) when it is encapsulated in pSiNPs. The photoacoustic response from ICG is enhanced 17-fold when it is sealed in pSiNPs. The substantially improved performance is attributed to the low thermal conductivity of pSiNPs and their ability to protect loaded ICG from photolytic degradation.