Silicon-Based Nanoparticles for Tissue-Specific Drug Delivery to the Brain

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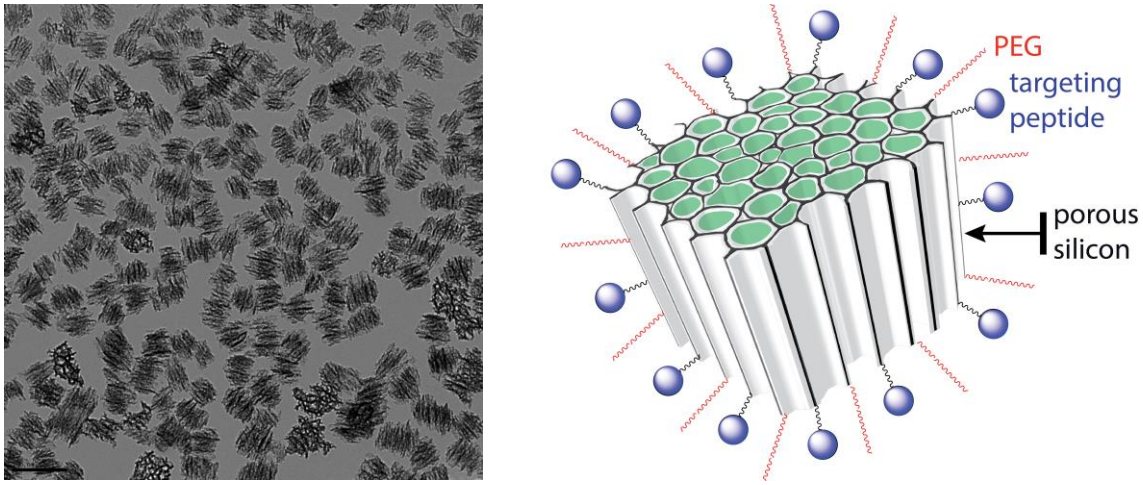
This presentation will highlight some of the challenges and potential solutions for translation of silicon-based nanotherapeutic systems, with an emphasis on sensing and targeting in the brain. Nanophase silicon is one of few semiconductor "quantum dot" materials that is non-toxic and that degrades to non-toxic byproducts *in vivo*. It offers advantages over polymer-based or lipid-based nanoparticles as a drug carrier, but it also poses several challenges. Advantages include the ability of a nanoscale silicon cage to protect and to load guest molecules such as nucleic acids and proteins at high levels. The fact that it displays intrinsic photoluminescence at tissue-penetrating near-infrared wavelengths avoids the need for additional labels to track the fate of the nano-carrier. The long-lived (microseconds) excited state lifetime that depends on the state of degradation of the material allows an additional dimension for evaluating parameters such as the extent of drug release or the local chemistry in the vicinity of the nanoparticle. Because of the sensitivity of biologics, chemistries used to trap that class of therapeutics must operate under mild aqueous conditions such that the payload becomes trapped without inducing denaturation or decomposition, and the chosen chemistry must still allow attachment of targeting peptides and other moieties to the exterior surface of the nanoparticle to enable selective tissue targeting. Focusing on small peptides as targeting agents, some recent examples of targeting, imaging, and cell penetration properties that show improved therapeutic outcomes for treatment of brain and neuronal injuries will be presented.



Left: Porous silicon nanoparticles by TEM. Nominal particle size is 200nm. Right: Porous silicon nanoparticle design.