Biodegradable Porous Silicon for Bioimaging

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Rationally designed biomaterials that provide high bioimaging signal intensity, high biosafety, precise targeting, and delivery of a variety of payloads are key toward effective treatment of diseases like cancer.[1-3] This research investigates porous silicon nanoparticles (pSiNPs) for photoacoustic imaging (PAI). The porous silicon NPs were generated by thermal reduction of silica NPs. Subsequently, the prepared pSiNPs were chemically functionalized with PEG using a simple silane and amide coupling chemistry to attach antibodies to specifically ovarian tumor. The prepared pSiNPs were systematically characterized through standard physicochemical characterization methods and assessed for their in-vitro, ex-vivo, and in-vivo bioimaging capabilities in two mouse models. With these two models we aim to demonstrate oral delivery of payloads and tracking of the dosage forms in inflammatory bowel diseases, and targeted bioimaging of cancer using these particles. We systematically evaluated photo-stability of the nanoparticles, degradation of the nanoparticles, their in-vitro and in-vivo contrast enhancement, and their targeting capabilities. The size of the pSiNPs was noted to be approximately 60 nm from the electron microscopy images and the dynamic light scattering. The pSiNPs displayed an approximately 7.5-folds in-vitro PA imaging (imaged using Vevo LAZR) signal enhancement compared to an FDA approved dye (Indocyanine Green; ICG, at comparable concentration). Similar PAI signal enhancement was achieved ex-vivo, upon local injection of pSiNPs in mouse cadavers - encouraging us to study their targeting ability. Whereas, the PA signal enhancement after oral administration of these particles (for oral delivery and tracking) in-vivo was approximately 3-folds, relative to ICG. In-vivo cancer imaging shows the ability of our particles to target the subcutaneously xenografted ovarian tumour specifically. Our data proves that our porous silicon nanoparticles can act as a bioimaging agent for photoacoustic imaging with significantly enhanced PA signal. In addition, the high surface area and the porous nature of these particles makes pSiNPs a suitable theranostic material.
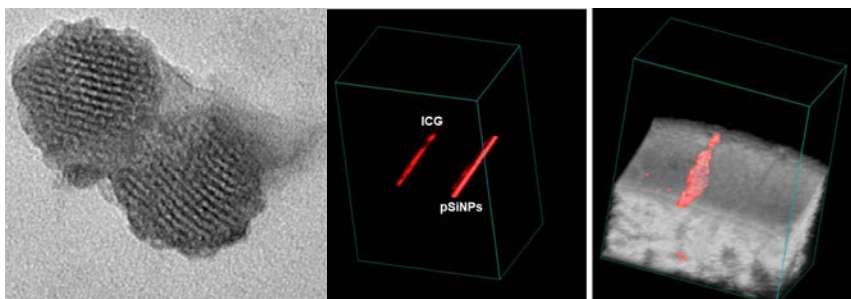
Figure 1. *Left:* TEM image of pSiNPs. *Middle:* In-vitro PAI of ICG and pSiNPs carried out at 8dB gain and concentration of 200μL/mL for both ICG and pSiNPs. *Right:* A 3D render of pSiNPs injected subcutaneously in a freshly euthanized mouse cadaver acquired at 16dB.

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