Harnessing long-lived photoluminescence of silicon nanoparticles for self-reporting drug delivery system

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An ideal nanocarrier that systemically delivers therapeutics would provide confirmation of drug delivery, however there is no way to monitor actual drug release and the delivery of active drug in vivo. Herein, we developed a self-reporting drug nanocarrier using porous silicon nanoparticles that report the release of drug payloads through intrinsic photoluminescence (PL). By tracking the PL signatures over time, drug elution status and the residual lifespan of the nanocarriers were correspondingly monitored. Particularly, the PL lifetime of the silicon nanoparticles was on the order of microseconds, which is significantly longer than the nanosecond lifetimes exhibited by fluorescent molecules naturally presented in cells and tissues, thus allowing for discrimination of the nanoparticles from tissue autofluorescence in a time-resolved manner. Upon in vivo circulation, the entrapped drug payloads were spontaneously released from the silicon nanocarrier by biodegradation showing strong correlation to dynamic PL characteristics. The PL lifetime is a physically intensive property that can report the inherent characteristics of the nanocarrier regardless of the surrounding noise.