From The Mine to Cancer Therapy: Natural and Biodegradable Theranostic Silicon Nanocarriers from Diatoms for Sustained Delivery of Chemotherapeutics

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Abstract:

Drug delivery using synthetic nanoparticles including porous silicon has been extensively used to overcome the limitations of chemotherapy. However, their synthesis has many challenges such as lack of scalability, high cost, and the use of toxic materials with concerning environmental impact. Nanoscale materials obtained from natural resources are an attractive option to address some of these disadvantages. In this paper, a new mesoporous biodegradable silicon nanoparticle (SiNP) drug carrier obtained from natural diatom silica mineral available from the mining industry is presented. Diatom silica structures are mechanically fragmented and converted into SiNPs by simple and scalable magnesiothermic reduction process. Results show that SiNPs have many desirable properties including high surface area, high drug loading capacity, strong luminescence, biodegradability, and no cytotoxicity. The in-vitro release results from SiNPs loaded with anticancer drugs (doxorubicin) demonstrate a pH-dependent and sustained drug release with enhanced cytotoxicity against cancer cells. The cells study using doxorubicin loaded SiNPs shows a significantly enhanced cytotoxicity against cancer cells compared with free drug, suggesting their considerable potential as theranostic nanocarriers for chemotherapy. Their low-cost manufacturing using abundant natural materials and outstanding chemotherapeutic performance has made them as a promising alternative to synthetic nanoparticles for drug delivery applications.

Keywords:

Diatoms; doxorubicin; luminescence; porous silicon; sustained release

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