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Drug delivery using silica nanotubes

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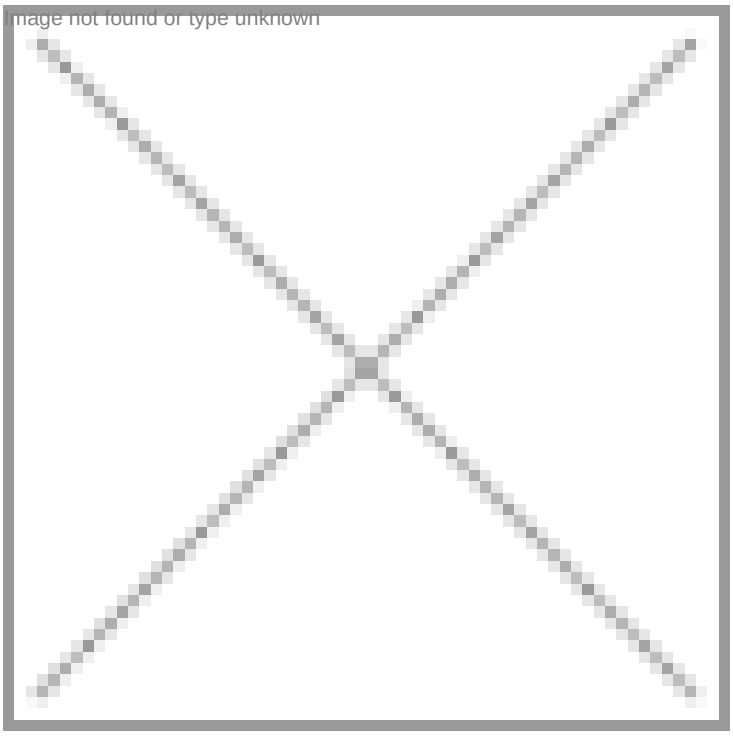

Drug delivery using silica nanotubes

The goal of all sophisticated drug delivery systems is to deploy medications to targeted parts of the body, nanotechnology provides the perfect trigger to achieve this

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Dr Aninda J Bhattacharyya and his students at the Solid State and Structural Chemistry Unit (SSCU), Indian Institute of Science (IISc), Bangalore, are exploring the possibilities of employing nanostructured materials for diverse biotechnological and environmental applications. They are making use of inorganic and hybrid (i.e. inorganic and organic) based nanostructured materials for controlled drug delivery and biosensing.

Dr Bhattacharyya says, “Recent experiments involving silica nanotubes (SNTs) and other mesoporous oxide materials have been very encouraging and we could see our efforts being useful to the medical fraternity as these porous materials could be used as versatile hosts for drug delivery and biosensing.”

The current methods of drug delivery exhibit specific problems that scientists are attempting to address. The therapeutic benefits of several drugs are limited or otherwise reduced because of the partial degradation that occurs before they reach a desired target in the body.

The goal of all sophisticated drug delivery systems, therefore, is to deploy medications intact to specifically targeted parts of the body through a medium that can control the therapy’s administration by means of either a physiological or chemical trigger. To achieve this goal, researchers are utilizing the scope of micro-and nanotechnology.

Drug delivery nanotechnology is just beginning to make an impact and these IISc researchers are using their expertise in materials chemistry to synthesize and manipulate molecules and supra-molecular structures for producing drug delivery

systems with programmed functions. In a recent scientific paper by Dr Bhattacharyya with his student Shobhna Kapoor published an article entitled 'Ultrasound triggered drug delivery and biosensing using silica nanotubes' in the journal of American Chemical Society, The Journal of Physical Chemistry-C. The researchers have reported application of SNTs for controlled drug delivery. (Ref: J Phys.Chem.C 2009, 113, 7155-7163)

"Inorganic porous materials have attracted considerable attention as hosts for the immobilization of a variety of guest molecules such as proteins, drugs and smaller biological molecules (amino acids, peptides and vitamins). In spite of being in the early stage, the inorganic nanostructured systems, such as, silica nanotubes offer an attractive improvement over prevailing organic systems for drug delivery," says Dr Bhattacharyya.

In the present work, these IISc scientists have reported in detail the procedures used for the preparation of the silica nanotubes. As a case study, the scientists have studied the in-vitro drug release kinetics of the common pain reliever Ibuprofen (IBU) in simulated body fluid (SBF). The extent of IBU loading in the silica nanotubes and several other parameters were monitored using sophisticated analytical tools, such as, thermogravimetry analysis (TGA), X-ray diffraction (XRD), and Fourier transform infrared (FTIR) spectroscopy.

IBU release kinetics was observed by monitoring the characteristic peak at 264 nm of IBU by Ultraviolet-Visible (UV-VIS) spectroscopy (Perkin-Elmer, Lambda 35 UV spectrometer). Ultrasound impulses (33 +/-2 kHz) of duration ranging from 0.5 min to continuous and with rest times between successive impulses ranging from 0 to 30 min were given to the SNT-IBU composite during release kinetics.

Dr Bhattacharyya observes, "In the present study, considering the drug release yields, say over a period of 24 hours, for Ibuprofen (IBU), our experimental results have been satisfactory. We believe that the drug dosages obtained for the bare silica nanotubes and silica nanotubes containing a coating of organic chemical groups can be further tuned via optimization of the nanotube morphological parameters that eventually leads to improved performance."

To increase the efficiency of the drug release from nanotubes, the researchers have experimentally shown the beneficial effects of using short ultrasound pulses as external stimuli. The purpose of application of an external stimulus will be highly beneficial for the solvent molecules as well as solvated drug to overcome several nanotube morphological heterogeneities. Further investigations are currently on to study the impact of several parameters on both degree of drug loading and the rate of release.

"We have demonstrated clearly the utility of a nanostructured material such as silica nanotubes both as a controlled drug delivery system and as a biosensor. We propose systems such as SNTs employed in the present study, to serve as a prototype for generation of systems having multiple functionalities for potential biotechnological applications, especially for drug delivery," adds Dr Bhattacharyya.

Nanotechnology has a great potential in revolutionizing the drug delivery field and the efforts of scientists such as Dr Bhattacharyya and his team of students at IISc could someday save a great number of lives.