Tunable Luminescent Carbon Nanospheres with Well-Defined Nanoscale Chemistry for Synchronized Imaging and Therapy

Major advances in the medical field have shortened surgical recovery times from weeks to only a few days. Reducing the size of the surgical incision is one key to this breakthrough. However, to decrease the incision size, the diagnostic and therapeutic tools must become smaller too.

The theranostic nanoplatform was developed to address that issue, but to date, several methodologies have been developed with materials that have low biodegradability and biocompatibility, and thus cannot be clinically tested. In addition, many require awkward synthesis or tedious purification processes, making them difficult to scale up to the large quantities needed for clinical use. To be effective, theranostic nanoplatforms must target a specific cell, have controlled drug release, and have robust sensors or imaging functionality to overcome physical barriers to in vivo diagnostics and therapy.

To develop a theronostic nanoplatform that is viable for clinical testing, ISTC's senior chemist John Scott partnered with University of Illinois researchers to develop a tunable luminescent carbon nanoparticles (LCN) that could be used as a theronostic nanoplatform that has both optical signaling and pharmacokinetic properties.

The LCN synthesis method that the team developed is simple and easily scalable. To start, Molasses, a polymer (either thermoresponsive [TR] or near infrared emitting [NIR-emitting]), and the drug were dissolved in Nanopure water and heated at 250°C for 20 minutes to concentrate the solution. Then the concentrated solution was suspended in Nanopure water and repeatedly centrifuged until carbon nanoparticles formed. Finally, the nanoparticles were purified using dialysis membrane and filtration and stored at 4°C.

Upon testing of the LCNs, the team found that the LCNs made with NIR-emitting polymer penetrated melanoma C32 cells better and caused faster cell death than the TR polymer LCNs. In addition, the NIR-emitting polymer LCNs were better for in vivo imaging because NIR light is significantly different than the natural wavelengths emitted from tissue, thus resulting in clearer images. However, the TR polymer LCNs were better for therapeutic drug release because the TR polymer LCNs exhibited a timed release of the drug, whereas the NIR-emitting polymer released the drug all at once. The team is confident that this new generation of LCNs has the ability to be easily modified for various therapeutic and diagnostic applications.

Meet the Scientists

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