Nanoshell-mediated near-infrared thermal therapy of tumors under magnetic resonance guidance.

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Recommended and a Commentary by Claire Gmachl, Princeton University.

One of the advantages that nano-structured materials have over bulk matter is the deliberate tunability in some of their characteristic properties. One example that has drawn considerable attention lately and is roughly summarized by the term “nano-plasmonics” concerns the tunability of the plasmon resonance in nano-patterned metal structures.

While the bulk plasmon energies, and with it the characteristic absorption edges, of bulk metals are well-known but hard-to-modify material parameters, the plasmon energies and resonant absorption energies of nano-patterned metal particles are easily tuned over large portions of the electromagnetic spectrum by simple choice of the particle size.

Hirsch et al. show how metal nanoshells can be tailored so that they are useful in the thermal ablative therapy of cancers. The authors use Au-silica nanoshells with 110 nm silica core diameter and 10 nm Au shell thickness. These particles are chemically synthesized and are tuned by choice of their physical dimensions to have their strongest absorption around 820 nm, where the intrinsic absorption of human tissue is very low and moderate laser radiation can penetrate deep beneath the skin without significant tissue damage, and where suitable lasers are readily available.

The combination of chemically inert, presumably non-toxic nanoshells and low-dose near-infrared radiation then presents a great opportunity to deliver heat to a location deep beneath the skin (to potentially cancerous tissue), by first delivering the nanoshells, which have been found to easily diffuse through tissue, followed by infrared laser radiation. The latter will only be absorbed by the nanoshells, thus leading to localized and targeted heat-delivery.

The authors successfully demonstrate this process both *in vitro*, on human breast cancer cells, and *in vivo* on tumors grown in mice. Cells with nanoshells are destroyed by a dose of infrared light that did not affect the viability of cells without shells.