

Chapter - 10

NANOSHELLS

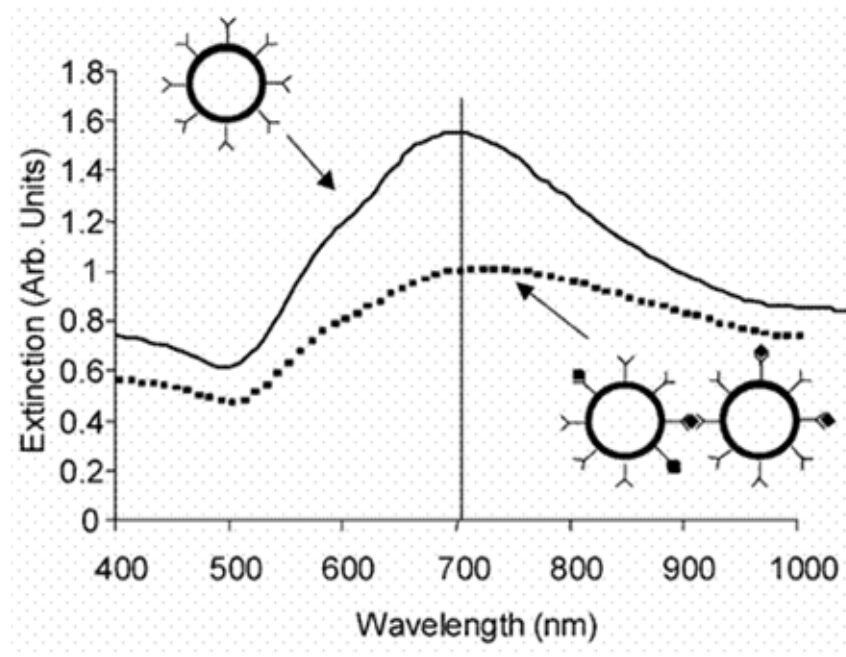


Fig. 10.1: UV-vis spectrum of dispersed nanoshells fabricated with a 96-nm-diameter core and 22-nm-thick gold shell (—); spectrum of nanoshells/antibody conjugates following addition of analyte (- - -). Extinction reduction upon aggregation in the presence of analyte was monitored at 720 nm, as indicated. Reprinted with permission from (L. R. Hirsch, J. B. Jackson, A. Lee, N. J. Halas, J. L. West, *Anal. Chem.* 2003, 75, 2377). Copyright (2003) American Chemical Society.



Fig. 10. 2: Nanoshells designed to absorb various wavelengths of light (the six vials on the right), including infrared (vial at far right) compared to gold colloid (far left). Used with permission from www.ece.rice.edu/people/faculty/halas.

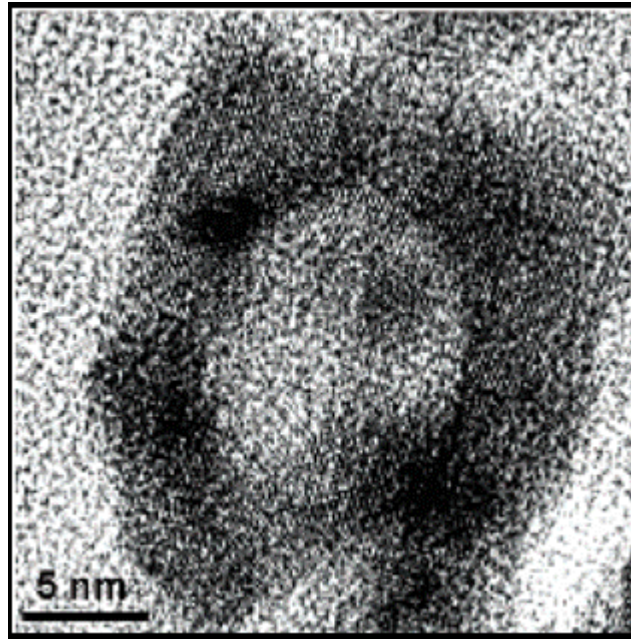


Fig. 10.3: High-resolution TEM photograph of an individual Au nanoshell. Reprinted with permission from (E. Hao, S. Li, R. C. Bailey, S. Zou, G. C. Schatz, J. T. Hupp, *J. Phys. Chem. B* 2004, 108, 1224). Copyright (2004) American Chemical Society.

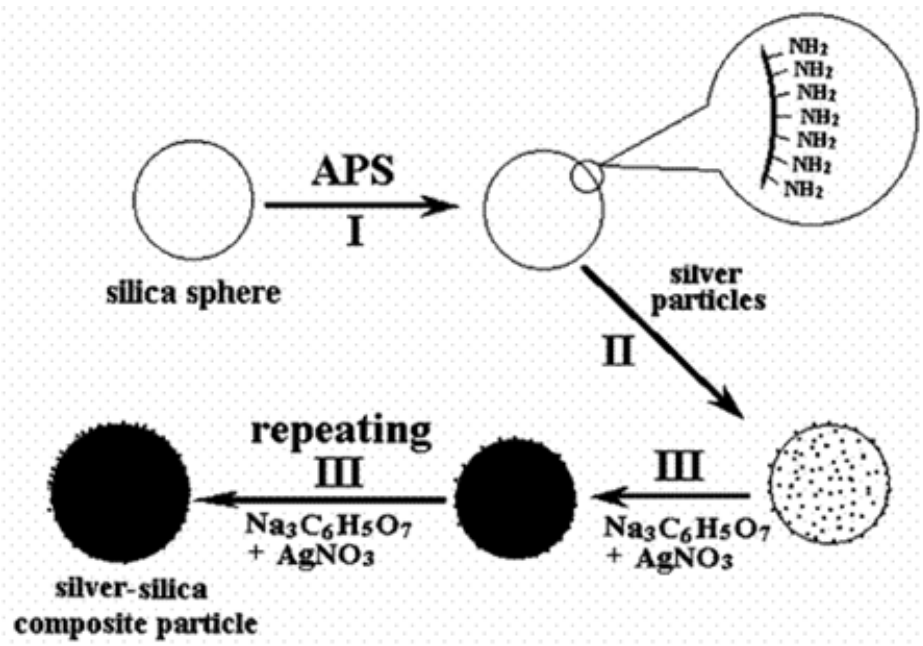


Fig. 10.4: Fabrication procedure of a silver nanoshell on the silica sphere. Reprinted with permission from (Z.J. Jiang, C. Liu, *J. Phys. Chem. B* **2003**, 107, 12411). Copyright (2003) American Chemical Society.

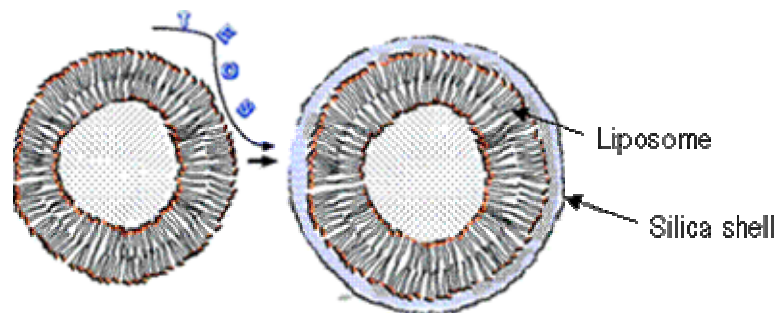


Fig. 10.5: Schematic of liposome covered with silica. Taken from the Graphical Content of (S. Begu, S. Girod, D. A. Lerner, N. Jardiller, C. T. Peteilh, J.M. Devoisselle, *J. Mater. Chem.* **2004**, 14, 1316). Reproduced with permission from the Royal Society of Chemistry.

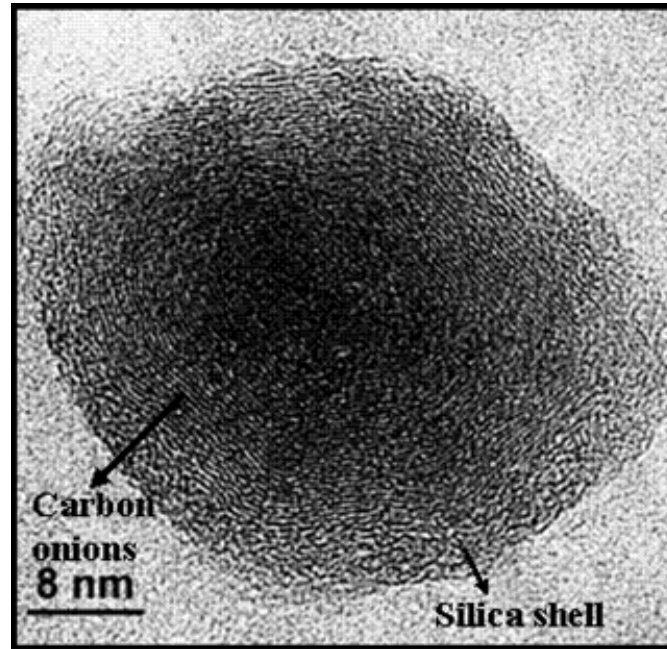


Fig. 10.6: High resolution TEM images of carbon onion containing shells. The outer few nm shows amorphous contrast and is the silica shell, inside this the typical concentric ring structure of carbon onions is seen, in this case more than 20 concentric graphitic planes are visible. Reprinted from (M. J. Rosemary, I. MacLaren, T. Pradeep, *Carbon* **2004**, 42, 2352). Copyright (2004), with permission from Elsevier.

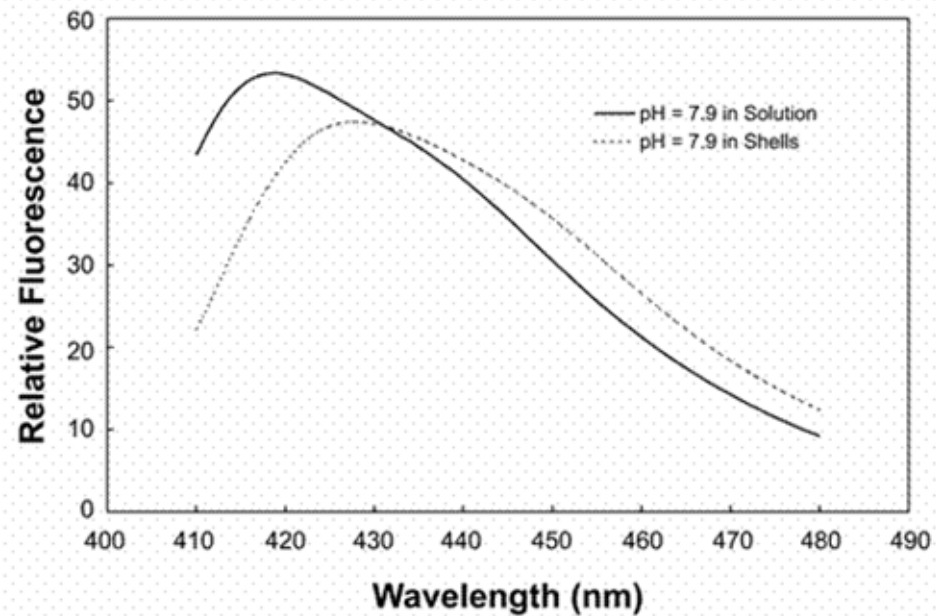


Fig. 10.7: Fluorescence spectra of Cascade Blue at pH 7.9 in water, and in silicate nano-shells. Reprinted from (E. Ostafin, M. Siegel, Q. Wang, H. Mizukami, *Micropor. Mesopor. Mater.* **2003**, 57, 47). Copyright (2003), with permission from Elsevier.

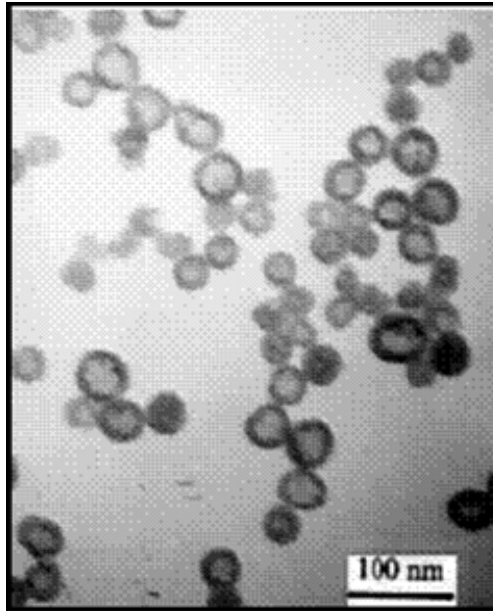


Fig. 10.8: A TEM micrograph showing nano-sized silica shells with an average inside diameter of ~15 nm containing 195 Cascade Blue dye per particle. Reprinted from (E. Ostafin, M. Siegel, Q. Wang, H. Mizukami, *Micropor. Mesopor. Mater.* **2003**, 57, 47). Copyright (2003), with permission from Elsevier.

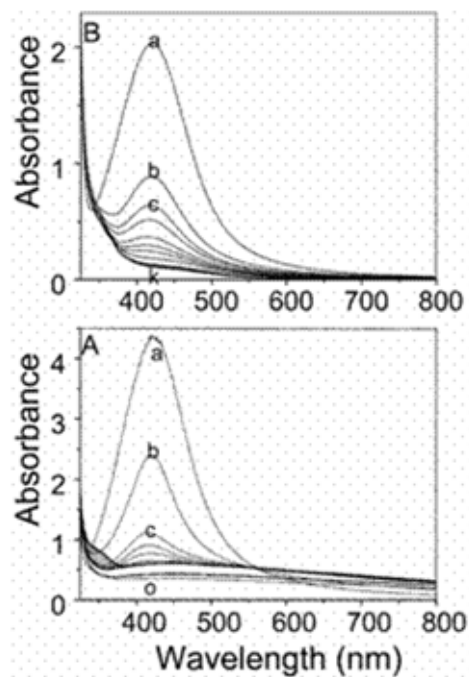


Fig. 10.9: Time-dependent UV–visible spectra of the reaction of Ag@ZrO₂ with (A) CCl₄ and (B) benzyl chloride indicating the selective leaching of the metal core. Trace *a* corresponds to the parent material. In (A) the traces were recorded after every 30 minutes and in (B) after every 10 minutes (after addition of CCl₄ and benzyl chloride, respectively). (A.S. Nair, R.T. Tom, V. Suryanarayanan, T. Pradeep, *J. Mat. Chem.* 2003,13, 297). Reproduced with permission from the Royal Society of Chemistry.

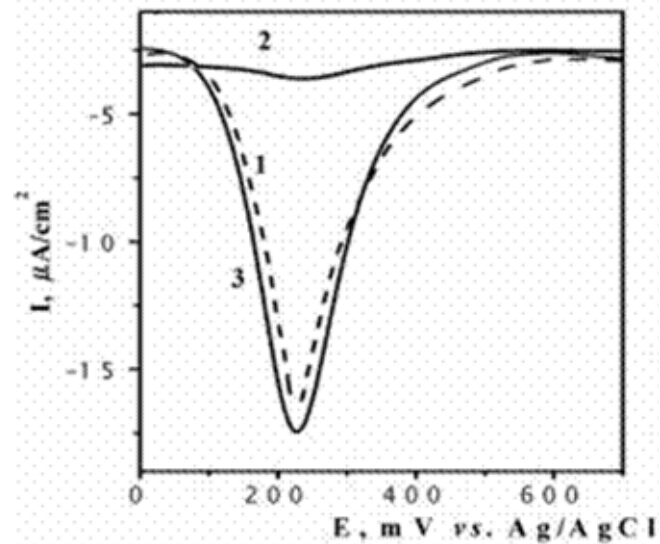


Fig. 10.10: Electrochemical dopamine sensing using an LbL of TiO₂ nanoshells. Reprinted from (D. S. Koktysh, X. Liang, B. Yun, I. P. Santos, R. L. Matts, M. Giersig, C. S. Rodriguez, L. M. L. Marzan, N. A. Kotov, *Adv. Funct. Mater.* **2002**, 12, 255). Copyright (2002) Wiley-VCH.

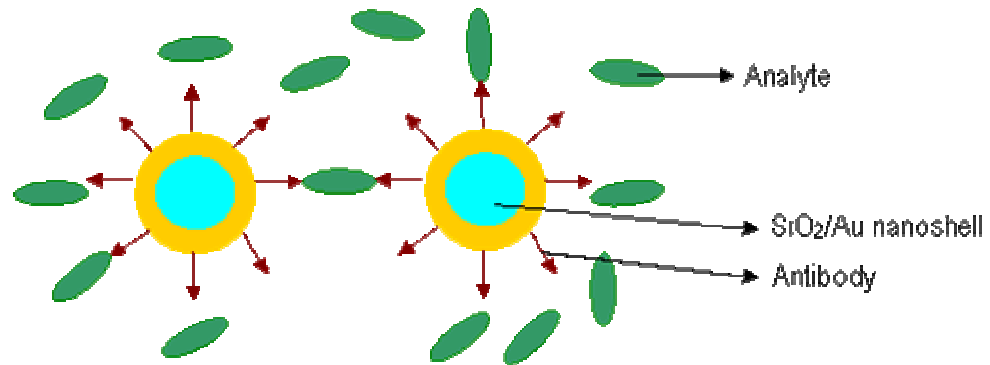


Fig. 10.11: Schematic of the interaction of a gold nanoshell modified using an antibody with an analyte. Adapted from (M. I. Brongersma, *Nature Materials* **2003**, 2, 296). Used with permission from the author, Copyright (2003) Nature Publishing Group.

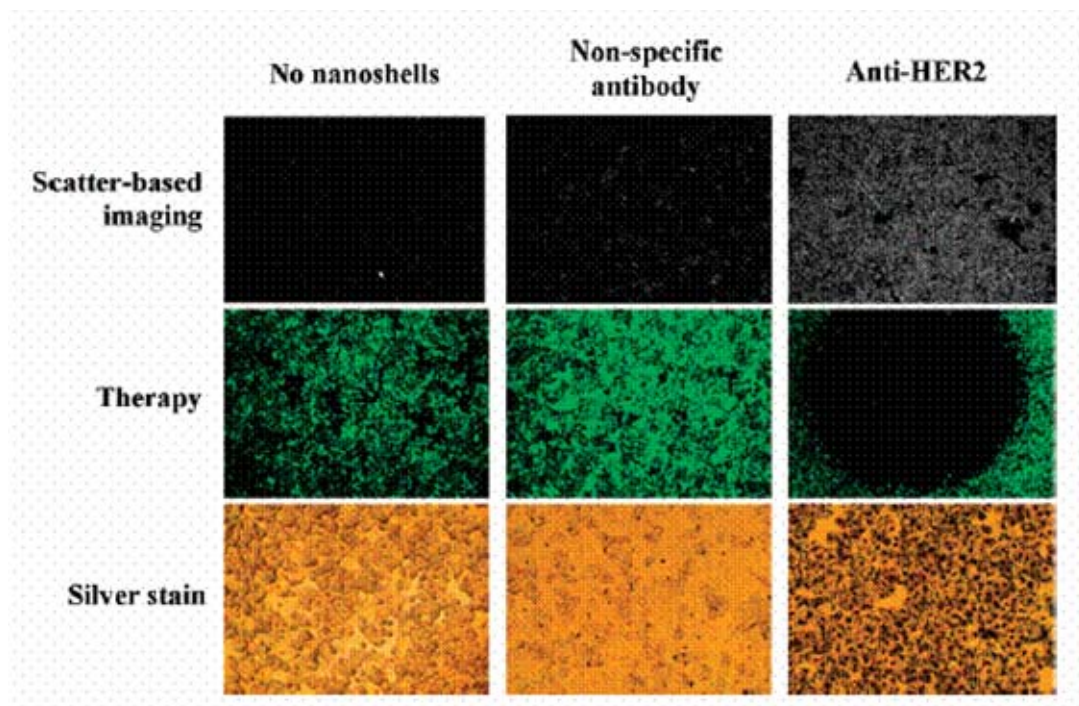


Fig. 10.12: Combined imaging and therapy of SKBr3 breast cancer cells using HER2-targeted nanoshells. Scatter-based darkfield imaging of HER2 expression (top row), cell viability assessed via calcein staining (middle row), and silver stain assessment of nanoshell binding (bottom row). Cytotoxicity was observed only in cells treated with a NIR-emitting laser following exposure and imaging of cells targeted with anti-HER2 nanoshells. Increased contrast (top row, right column) and cytotoxicity (dark spot) are seen in cells treated with nanoshells as compared to others, called controls (left and middle columns). (L. Christopher, L. Amanda, N. Halas, J. West, R. Drezek, *Nano. Lett.* **2005**, 5, 709). It is important to note that all experiments of this kind are done with appropriate controls. Reprinted with permission from (L. Christopher, L. Amanda, N. Halas, J. West, R. Drezek, *Nano. Lett.* **2005**, 5, 709). Copyright (2005) American Chemical Society.