Fabrication of dual-mode core-shell microparticles for Raman and photoacoustic imaging

Daniil Nozdriukhin[1, 2], Nadezhda Besedina[2], Polina Rudakovskaia[1], Vasiliy Chernyshev[1], Alexey Yashchenok[1], Dmitry Gorin[1]

[1] Skolkovo Institute of Science and Technology, Bolshoy Boulevard 30, 121205 Moscow, Russia
[2] St Petersburg Academic University, Khlopina str. 8, bld. 3, lit. A, 194021 St. Petersburg, Russia

Core-shell microparticles were prepared using Layer-by-Layer (LbL) assembly [1, 2] by deposition of positively and negatively charged polyelectrolytes polystyrene sulfonate (PSS) and poly (diallyldimethylammonium chloride) (PDADMAC), PSS-modified single-walled carbon nanotubes (SWCNT) and 10 nm gold nanoparticles (AuNP). To control the growth of composite shell on the surface of silica microparticles zeta potential, UV-vis (300-800 nm) and Raman (at 785 nm excitation) spectra were measured. UV-vis data showed that only upper layer on the surface has an impact on absorbance spectrum. SERS signal from the sample comprising two layers of SWCNT and AuNP was 7 times higher compared to the structure with one layer of SWCNT and AuNP (Fig.1). These samples were also tested on a portable Raman spectrometer (B&WTek company) and exhibited same enhancement as was observed with Horiba microspectrometer. In addition, the samples were investigated by using optoacoustic mesoscopy P50 RSOM system by iTheraMedical and showed relatively high photoacoustic intensity in agarose phantom (Fig.2). We anticipate that the results from this research can be useful for construction of dual-mode contrast agents for biological sensing and imaging applications.

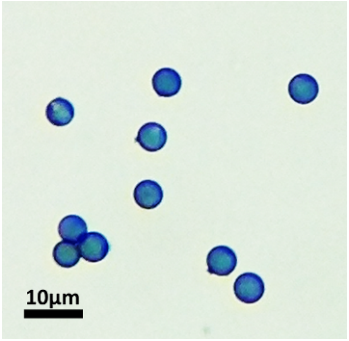

Fig. 1: Optical image of core-shell microparticles with one layer of SWCNT and AuNP.

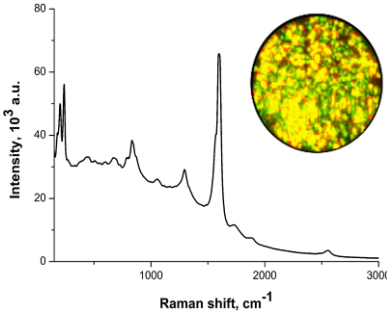

Fig. 2: SERS spectrum and photoacoustic image (inset) of core-shell microparticles with two layers of SWCNT and AuNP

[1] A. G. Skirtach et al., Chem. Commun. 47 (2011) 12736–12746
[2] A.Yashchenok et al., Small 11 (2015) 1320-1327