

# Synthesis and characterization of pH-sensitive hybrid janus nanoparticles

P. G. Falireas,\* M. Vamvakaki

*Institute of Electronic Structure and Laser, Foundation for Research and  
Technology – Hellas, 711 10 Heraklion, Crete, Greece*

*Department of Materials Science and Technology, University of Crete, 710 03  
Heraklion, Crete, Greece*

Janus nanoparticles [1], named after the double-faced Roman god, are compartmentalized colloids with two sides of different chemistry or polarity. These particles have attracted significant attention in recent years due to their unique properties which derive from their anisotropic character. In this study, we present the synthesis and characterization of amphiphilic hybrid janus nanoparticles comprising an inorganic silica core and a shell consisting of compartmentalized poly(acrylic acid) (PAA) and poly (2-(dimethylamino)ethyl methacrylate) (PDMAEMA) polymer brushes.

In the first step, silica nanoparticles ( $D = 100$  nm) were used to stabilize polystyrene colloidosomes [Figure 1]. The exposed surface of the silica nanoparticles was modified with an atom transfer radical polymerization (ATRP) initiator. After the functionalization, polystyrene was dissolved yielding janus nanoparticles bearing ATRP initiating sites. Next, surface-initiated ATRP of *tert*-butyl acrylate (*t*-BuA) was carried- out from the one hemisphere of the initiator-functionalized silica nanoparticles followed by functionalization of the second hemisphere with the ATRP initiator. Finally, ATRP of DMAEMA was conducted to obtain amphiphilic hybrid janus nanoparticles. Acidic hydrolysis of the P(*t*-BuA) ester groups led to oppositely charged polyampholyte janus particles [2] decorated with PAA and PDMAEMA polymer chains.

The Janus character of the particles was confirmed by thermogravimetric analysis and scanning and transmission electron microscopies (SEM and TEM), whereas the molecular weights and molecular weight distributions of the P(*t*-BuA) and PDMAEMA polymer brushes were determined by gel permeation chromatography. The dual responsive behavior of the janus nanoparticles in water as a function of temperature and pH was investigated by dynamic light scattering and potentiometric titration.

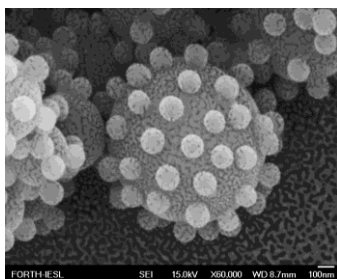


Figure 1: SEM image of the polystyrene-SiO<sub>2</sub> colloidosomes

## References

- [1] de Gennes, P.G., *Soft Matter. Science* **256**, 495 (1992).
- [2] Berger, S., et al., *Macromolecules* **24**, 9669 (2008).

---

\* pfalir@iesl.forth.gr