

Stimuli responsive core-shell silica nanoparticles

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INTRODUCTION: Silica nanoparticles gain increasing interest because of their excellent properties such as low density, high specific surface area, adsorption capacity, and the ability for encapsulation. These characteristics can be combined in a hybrid particle with the pH and temperature sensitivity of star shaped polyelectrolytes like poly(*N,N*-dimethylaminoethyl methacrylate (poly(DMAEMA)). The polymers form a template for the condensation of tetraethyl orthosilicate (TEOS), which leads to the formation of a silica shell around the polymer molecules.

Here, we investigated the morphology of the silica nanoparticles. The core shell structure of the particles makes them highly interesting for host / guest encapsulation that is relevant for bioimaging or triggered release. Particularly interesting is that the polymer core of the particles shows a pH and temperature dependant solution behavior and ion-specific effects. The associated conformational changes of the polymer create a disruption of the inorganic shells that can be used as a trigger for controlled release.

METHODS: Core-shell silica particles were synthesized proceeding from Poly{[2-(methacryloyloxy)ethyl] trimethylammonium iodide (PMETA⁺I⁻)¹ as templates by condensation reaction of tetraethyl orthosilicate (TEOS) in aqueous solution. The resulting particle size and structure was determined by TEM, SEM and AFM. Host / guest encapsulation and triggered release were detected by Fluorescence Correlation Spectroscopy (FCS) using a Zeiss ConfoCor 2 setup.

RESULTS: Based on various concentrations of silica monomer the particles resulted in different shapes as shown in Fig. 1 and 2.

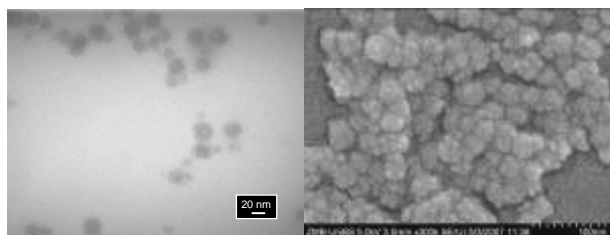


Fig. 1: TEM and SEM from particles obtained with 13.4mM TEOS

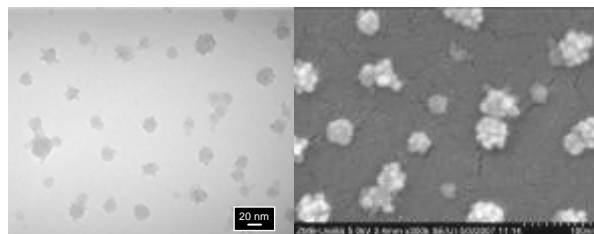


Fig. 2: TEM and SEM from particles obtained with 44.8mM TEOS

A small concentration of TEOS directed to spherically shaped particles with a lower density in the core (Fig.1). Raising the amount of silica monomer leads to blackberry-shaped particles (Fig.2).

FCS showed that an encapsulated dye (Sulforhodamine G) could be released from core-shell silica nanoparticles after changing the pH of the solution (Fig.3).

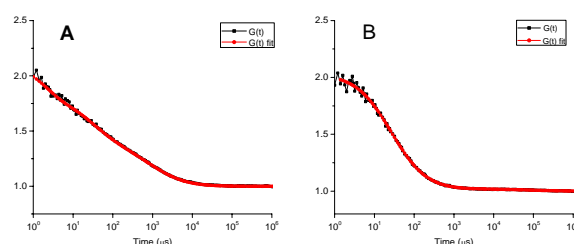


Fig.3: Autocorrelation curves of core-shell silica nanoparticles (in aqueous solution) with encapsulated dye (Sulforhodanine G) at pH6 (Reference) (A) and at pH9 (B).

DISCUSSION & CONCLUSIONS: Concerning these tunable core-shell silica particles there is a potential of encapsulation and following release of applicable substances. Due to the small size and their properties these hybrid particles can play an important role in bioimaging

REFERENCES: ¹F.A. Plamper, A. Walther, Axel H.E. Müller, M. Ballauff (2007) Nano Letters 7 (1):167-171.

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