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SOFTMAT

Optimization of organosilica particle synthesis

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Introduction

Silica particles are used in various of applications, such as storage and high-performance catalysis, but also academic applications where silica nanoparticles are used as building blocks for a colloidal gel network. Pure silica particles can be fabricated using different strategies, one of which being the well understood “Stöber process” [1], where a silane such as tetraethyl orthosilicate (TEOS) is added to a mixture of ethanol, water and ammonia. The particle size can easily be tuned by changing the composition of the mixture in order to get monodisperse colloids [2]. Different kinds of organosilica particles have already been synthesized using silanes with a functional group such as amine [3], thiol [4], epoxy [5], etc, but are difficult to synthesize in a monodisperse and uniform manner (see Fig. 1). The particle formation process is not that well understood as for TEOS particles, however they have the advantage of having a high functional group density, which will enable grafting of larger molecules to the particle surface.
In this project, we first want to develop a protocol to synthesize round, monodisperse organosilica particles of a controllable size in a reproducible manner. In a second step, we will investigate the synthesis of rough particles by using a mix of different silane precursors [6].

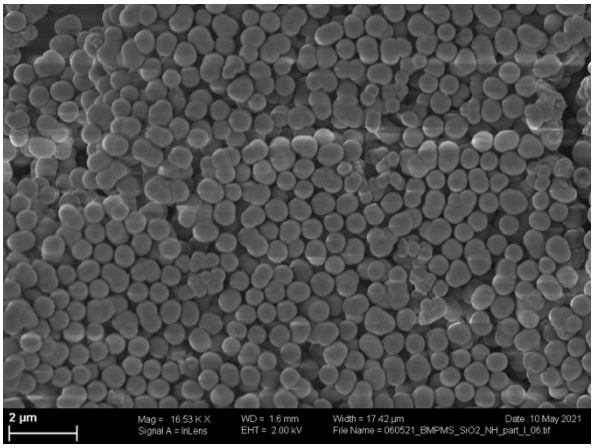

Fig. 1. SEM image of organosilica particles

Methods used in the project

- Chemical synthesis
- Dynamic laser scattering (DLS)
- Thermogravimetric analysis (TGA)
- Scanning electron and atomic force microscopy (SEM/AFM)
- UV-Visibility spectroscopy

References

1. Stöber, W., A. Fink, and E. Bohn, *Controlled Growth of Monodisperse Silica Spheres in the Micron Size Range.* Journal of Colloid and Interface Science, 1968. **26**.
2. Greasley, S.L., et al., *Controlling particle size in the Stöber process and incorporation of calcium.* J Colloid Interface Sci, 2016. **469**: p. 213-223.
3. Zhou, G., et al., *Highly functionalized bridged silsesquioxanes.* Journal of Sol-Gel Science and Technology, 2012. **62**(3): p. 470-482.
4. Nakamura, M. and K. Ishimura, *One-Pot Synthesis and Characterization of Three Kinds of Thiol-Organosilica Nanoparticles.* Langmuir, 2008. **24**.
5. Nakamura, M. and K. Ishii, *Size-Controlled, One-Pot Synthesis, Characterization, and Biological Applications of Epoxy-Organosilica Particles Possessing Positive Zeta Potential.* Langmuir, 2008. **24**.
6. Liang, R., et al., *One-step synthesis of golf ball-like thiol-functionalized silica particles.* Soft Matter, 2020.