**Synthesis, stability and CO2 uptake of mesoporous colloidal silica in aqueous media**

Diagram

Description automatically generatedA sofar unexplored method for storage and capture of CO2 is, to adsorb the CO2 into colloidal silica particles, suspend the particles in salt solution and store the concentrated suspensions in large (e.g. subsurface) reservoirs. By chemically modifying mesoporous silica particles with amines, a model system is obtained that should be able to capture CO2 from the gas phase [1]. However the behavior of the CO2 loaded particles *in aqueous solutions* has not been studied. This recently started research is part of a collaboration between the PCF and SPT groups at the UT, and will also become part of a PhD research project in 2022.

Left: TEM image of mesoporous silica, from ref [1]. Right: Schematic of setup used for measuring CO2 uptake/release.

## Research objectives

1) can we reproduce the particle synthesis from literature?

2) do the particles remain colloidally stable in aqueous liquids?

3) can the particles capture and retain CO2?

In the BSc project you will address one of these questions, depending on the stage of joining.

1.The particle synthesis resembles the well-known Stöber method [2], but instead of ammonia we use dodecyl-  
 amine, which serves both as a catalyst and a sacrificial material to create the pores. Additionally, APTES is used   
 to functionalize the pores with CO2-binding amino groups. Possible characterization techniques are SEM, AFM,   
 XRD for morphology and BET, IR, TGA for chemical identification.

2.Particle sizes are expected in the range of 0.4-1 μm, allowing the use of optical (fluorescence\*) microscopy   
 (CSLM) to study the colloidal stability in solutions of varying salinity and pH. The (non-) occurrence of particle   
 aggregation can also can also be studied via light scattering, settling velocity or zeta potential. This part of the   
 research connects well to the Advanced Colloids and Interfaces course. (\* Fluo-dyes like FITC or RITC can be perma-  
 nently incorporated in silica, via binding to APTES [3]. It might be possible to achieve this also for the mesoporous silica).

3. CO2 uptake and release by the particles can be studied in different ways. In the dry state volumetric, TGA and   
 IR methods can be used. For liquid-dispersed colloids, the gas volume and/or pH changes can be measured.

## Learning objective

Apart from the standard learning objectives for a bachelor’s project (research planning, academic writing, data presenting, how to work in a lab environment, etc.), you will:

* Obtain knowledge on colloidal characterization techniques
* Obtain hands-on experience with colloids
* Learn how to measure CO2 uptake by aqueous fluids and compare with equilibrium calculations
* Depending on the specific project, synthesize colloids and/or visualize them with CSLM.

## Contact information

Dr. Michel Duits, PCF group, <https://people.utwente.nl/m.h.g.duits>

## Literature

1.\_Araki, S., Doi, H., Sano, Y., Tanaka, S., Miyake, Y. (2009). Journal of colloid and interface science, 339, 382-9

2.\_Stöber, W., Fink, A., & Bohn, E. (1968).  Journal of colloid and interface science, 26(1), 62-69.

3.\_Verhaegh, N. A., & Blaaderen, A. V. (1994). Langmuir, 10(5), 1427-1438.