Pickering Emulsions using a Fumed Silica and a Silica Sol - The Effect of Microfluidization

Karin Persson, Jan-Willem Benjamins, Jens Sommartune and Isabel Mira, RISE Research Institutes of Sweden
Bernard P Binks, Department of Chemistry and Biochemistry, University of Hull

Background
The ability of colloidal silica to stabilize nano-oil-in-water emulsions prepared using a Microfluidizer® has previously been demonstrated [1]. A vast amount of work has been performed and reported on fumed silica-stabilized emulsions. Nevertheless, the possibility to reduce the emulsion droplet size in these emulsions by means microfluidization has not been tested.

- **Objective:** investigate the smallest emulsion droplet size attainable in fumed silica-stabilized emulsions by means of microfluidization.

Materials

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<th>Sample</th>
<th>Preparation</th>
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| Fumed Silica | 10 wt% oil-in-water, pre-emulsification step, microfluidized for 30 min. Method 2 provides the most stable emulsion. Droplet size is constantly 2.5-20 µm between 1 week and 1 month.
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| Bimodal size distribution. The smaller peak may be silica.
| Silica Sol | 5 wt% oil-in-water, pre-dispersed in microfluidizer, microfluidized for 30 min.

Microfluidization
A M 110V Microfluidizer processor (Microfluidics, USA), with a F207Y 75 µm interaction chamber (Y type) with a H30 Z 200 µm auxiliary chamber (Z type) placed inline and pressure of 60 bar was used.

Emulsification using a Fumed Silica (Reference system)
Emulsions stabilized with sols of hydrophobically - modified silica (Levasil CC301) had a droplet size of 0.092 µm (volume mean diameter). No variations in droplet size were observed for at least a month (previous work indicates that these type of emulsions remain stable for years).

Morphology of Fumed Silica-stabilized Emulsions using Confocal Raman

- **The droplets are not spherical.**

Freeze-thaw Stability of Silica-stabilized Emulsions
Emulsions stabilized with starch granules have been reported to exhibit high freeze-thaw stability [2].

The freeze-thaw stability of the fumed silica and Levasil CC301-stabilized emulsions was tested. The emulsions were placed in a freezer at -18°C for a week and allowed to thaw at RT before their size distribution was measured.

- **The silica stabilized emulsions are not stable to freezing, and a significant increase in droplet size of the emulsions occurs.**

Summary
Levasil CC301
- Levasil CC301 is a good stabilizer for nano-oil-in-water emulsions.
- Emulsions with droplet size of 0.092 µm (volume mean diameter) were obtained with Levasil CC301.
- These emulsions are stable at least one month

Fumed Silica
- Fumed silica is good for stabilization of emulsions with droplets sizes larger than 2 µ, but it is not suitable for stabilization of nano-emulsions.
- Fumed silica can stabilize a 10% oil-in-water emulsions however, the droplet size of these are larger (2.5-10 µm), and they grow with time.
- Using less oil (5%) and pre-dispersing the fumed silica in the Microfluidizer results in an emulsions with a droplet size of 2.5-20 µm.
- The 5% emulsion was stable for at least one month

Freezing
- The silica stabilized emulsions were not stable to freezing/thawing.