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Production of silica particles by membrane emulsification

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In the last few years there has been increasing interest in the production of porous inorganic materials with high surface area. Such materials have potential application in various fields of catalysis, separation, sorption, bioreactor, sensors and so on. Silica is an inorganic material that does not swell and with its good mechanical and thermal stability it can be used in various solvents and have wide applications. In the literature silicon alkoxide or tetraetoxisilane are mainly used as silica sources. The main drawback of using such materials is that they are expensive and therefore production of large quantities of silica would not be cost effective.

In this work silica particles were successfully produced from precursor sodium silicate droplets using membrane emulsification. In membrane emulsification monosized emulsion is produced by injecting one liquid phase (e.g. water) through microporous membrane into a second immiscible liquid phase (e.g. kerosene). The droplet size is mainly controlled by the shear stress applied on the membrane surface and the pore size (Vladisavljević and Williams 2005).

The Dispersion Cell (Kosvintsev et. al 2005) with a hydrophobic nickel membrane attached on the bottom of the cell (Fig. 1 a,b) was used to generate emulsion. A mixture of sodium silicate (silica source) and sulphuric acid (gel-forming reagent) was used as dispersed phase and kerosene containing 2% Span 80 was used as a continuous phase.

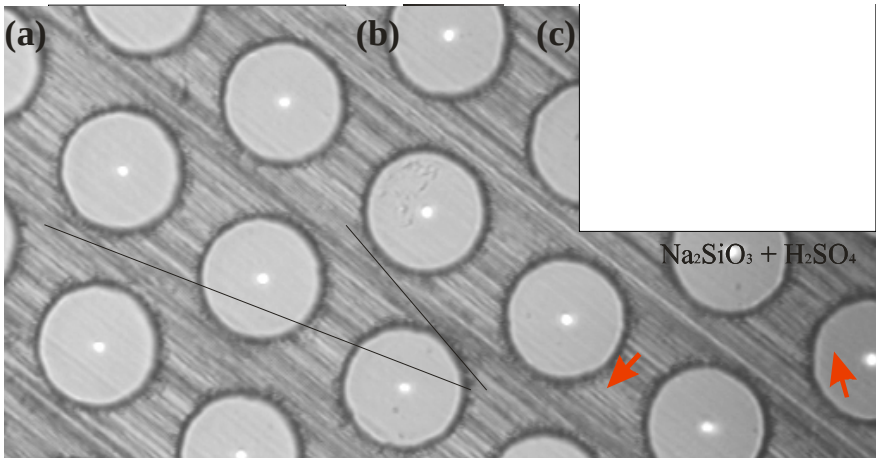

Figure 1. (a) Hydrophobic nickel membrane with 15 µm pores and (b) Dispersion Cell both kindly provided by Micropore Ltd. UK. (c) SEM of calcined silica particles with a mean size of

In most of the experiments flux of the dispersed phase was kept constant at 350 L m^{-2} h^{-1}. It is widely accepted that the shear stress on the membrane surface has to be applied in order to get uniform droplets. In the Dispersion cell the shear stress is induced with the paddle stirrer place on top of the membrane. By changing the shear stress on the membrane surface liquid silica droplets in the range between 50 and 160 µm were produced. After solidification of silica the particles were washed and dried at room temperature followed by calcination at 550°C. After final drying the size of the produced silica particles was in the range between 30 and 70 µm (Fig. 1c). BET specific surface area of the produced silica after calcination was found to be 750 m^2/g while the average pore diameter was 1.3 nm.

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