Investigation of the Formation Mechanisms of Mesoporous Silica Structures by Local Dielectric Variations

G.A.T. Sandanuwan, N.L.W Wijewantha, D.R.D Kumara, D. Attygalle, V.S.C Weragoda, D.A.S Amarasinghe

Department of Materials Science and Engineering, University of Moratuwa, Sri Lanka

Abstract

Since their discovery mesoporous silica has been widely used in various fields like waste water purification, indoor air cleaning, catalysis, bio-catalysis, drug delivery, CO_2 capture, bioanalytical sample preparation. This is mainly due to their unique properties such as ordered pore structures, large pore areas and fairly high chemical inertness. Mesoporous silica can be synthesized in a wide range of morphologies such as spheres rods, discs, powders, etc. Unlike traditional porous silica, mesoporous silica exhibit exceptionally ordered pores.

The interaction between inorganic precursor and organic template plays a major role in the mesoporous structure formations. Therefore, it is important to understand these interactions in detail to develop new porous materials as well as to modify existing materials. According to the conventional micelle chemistry, effective local surfactant parameter (p) is the mesophase deciding factor. Depending on the value of p different mesophases; $p < 1/3$ cubic –*pm3n*, $1/3 < p < 1/2$ hexagonal *p6m*, $1/2 < p < 2/3$ cubic *la3d* and $p = 1$ lamellar are formed.

Though there are several mechanisms proposed for these mesoporous material formations in scientific literature, none of the proposed mechanisms provides an exclusive and definite answers. So aim of this research is to shed some light on these unanswered questions on mesoporous silica formation mechanisms.

In this research silica based mesoporous material was prepared in the presence of Cetrialmethylammonium Bromide (CTAB) as a structure directing agent and Pyrene as the probe molecule. As probe material's emission spectrum is change due to its interaction with CTAB, the mechanisms in which micelle and silica formation were studied. Analysing spectroscopic data, Critical Micelle Concentration (CTC) and mechanism in which it interacts with Silica are present here.