272c Synthesis of Ordered Mesoporous Tin Oxide Thin Films Displaying Extremely High Thermal Stability: a Tem and Saxs Study of Structural Changes during the Thermal Treatment

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Thin films of mesoporous metal oxides having semiconducting properties (e.g. TiO_2, SnO_2, ZnO) are of technological interest due to their promising applications in dye sensitized solar cells, photocatalysis, gas sensing etc. Mesostructural stability at high temperatures (>600 °C) is desired for these materials as the higher degree of crystallinity of the inorganic framework obtained by subjecting these materials to high temperatures is expected to lead to better performance for above applications.

Recently we reported mesoporous tin oxide thin films thermally stable up to 600 °C.[1] Here we report that the high temperature calcination stability of these materials can be significantly improved by subjecting them to elevated temperatures (<250 °C) for extended periods to enhance the degree of condensation prior to surfactant removal by calcination. After subjecting the films to this extended thermal treatment, they can be calcined at temperatures greater than 1000 °C, without the collapse of the mesostructure. Such high thermal stability has not been reported for mesoporous metal oxides previously. The structural changes taking place in the films during the extended thermal treatment and during surfactant removal by calcination were investigated using small angle X-ray scattering (SAXS) and TEM imaging. The temperature of crystallization of the inorganic framework was determined using electron diffraction. After subjecting the films to higher temperatures, the SAXS patterns indicate that the principle direction of electron density variation is parallel to the substrate, indicating possible access to the mesopores from the top of the films.

1. Urade V.N. and Hillhouse H.W. *Journal of Physical Chemistry B* **2005** Published on the Web DOI: 10.1021/jp051229+