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Observation of Hierarchical Porous $BaTiO_3$ Derived from Hard Template

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The morphology control at the mesoscale, via the design of size, shape, surface, interface, porosity and patterning of the meso-components, has gained increasing attention in the recent past and is expected to endue materials with novel functions. Most reports on mesoporous materials are on amorphous silica or simple oxides with amorphous or polycrystalline framework. It is still quite challenging to achieve functional multi-metal-oxides possessing highly porous structure. On the other hand, the synthesis and characterization of nano-sized ferroics has recently become important since it was predicted a dependence, for instance of the ferroelectric response, on the size and morphology [1]. Moreover, the combination of different materials at the nanoscale creating multifunctional nanocomposites, where new properties resulting from scale, interface and defect phenomena are expected, is a new field that requires exploitation. Crystal size, surface area, surface curvature, and charges on the surface singnificantly influence the physical properties of ferroics at the nano-scale. Within our studies of the porous ferroelectrics, we have prepared $BaTiO_3$ crystals with nanoporosity inside with a sol-precipitation process involving polymer or surfactant micelles [2, 3]. In this work, we present the microscopic characterization of porous $BaTiO_3$ derived from hard matrix.

Mesoporous carbon CMK-3 was used as the matrix. $BaTiO_3$ precursor solution was impregnated into the channels of CMK-3. Carbon-$BaTiO_3$ composite was attained after heat treatement on the impregnated CMK-3 in a N_2 atmosphere. By HRTEM, the fringes of $BaTiO_3$ crystallite confined in the channels of mesoporous carbon were clearly observed. Dependence of heat treatment time and temperature on the crystallinity were investigated.

Hierachical porous $BaTiO_3$ structures were attained after the thermal removal of the carbon matrix. The typical morphology of porous $BaTiO_3$ particles is shown in Figure 1 and Figure 2. High resolution SEM free from carbon coating and TEM are powerful techniques to study the hierachical porous structure and to give informations on the formation mechanisms. The particle morphology succession from carbon matrix to the carbon-$BaTiO_3$ composite, then to the $BaTiO_3$ was identified. However, the hexagonal symmetry of the porous structure possessed by CMK3 was lost in $BaTiO_3$. It is attributed to the exaggerated grain growth of $BaTiO_3$ that occurred during the combustion of carbon matrix.

The introduction of “porous” concept to conventional ferroelectrics may lead to unique properties resulting from the special meso-structure characteristics such as high specific surface area and modified correlation among nano-sized blocks.

References

[1] A. N. Morozovska, E. A. Eliseev, M. D. Glinchuk, Physica B, 387 (2007) 358.
[2] R. Z. Hou, P. Ferreira, P. M. Vilarinho, Microporous Mesoporous Mater., 110 (2008) 392.
[3] R. Z. Hou, P. Ferreira, P. M. Vilarinho, Chem. Mater., under revision.

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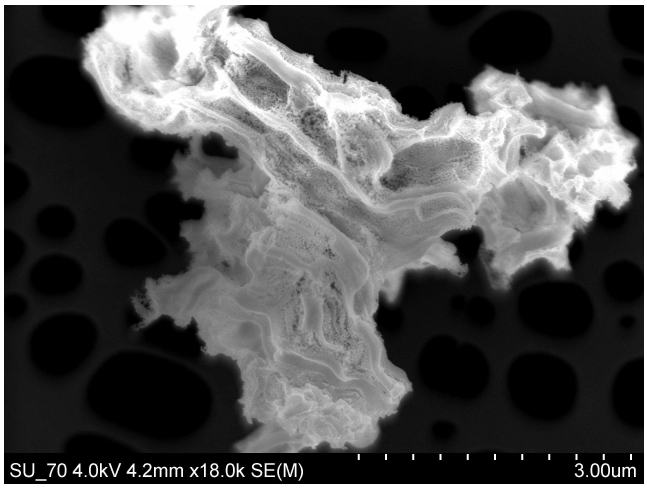

Fig. 1. SEM image of the hierarchical porous $BaTiO_3$ particles.

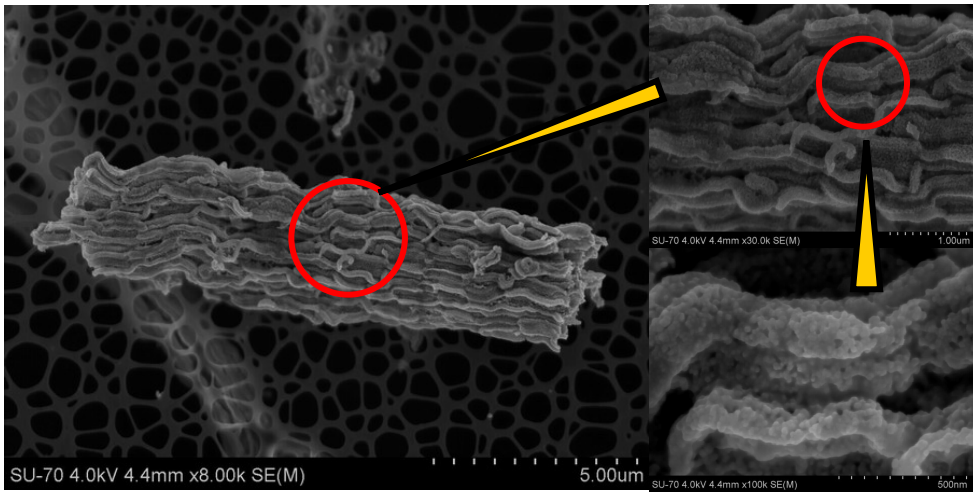

Fig. 2. A trunk-like $BaTiO_3$ particle composed of porous fibers.

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