ナノ多孔性 $BaTiO_3$ 薄膜における精密設計

（東京電機大）○鈴木 孝宗

Precise Design of Nano-porous $BaTiO_3$ Thin Films (*Tokyo Denki University*)

○Norihiro Suzuki

Although barium titanate ($BaTiO_3$: BTO) is an old ferroelectric material, which was discovered in 1940s, it is still commonly used due to its environmentally-benign (i.e., lead-free) character as well as well-balanced properties among ferroelectricity, piezoelectricity, and dielectric constant. BTO has an anisotropic ferroelectricity and its Curie temperature (i.e., the temperature at which ferroelectricity disappears due to a phase transition) enhances by lattice distortion induced by nano-porosity[1), 2)]. In this study, to maximize the ferroelectricity of a nano-porous BTO thin film, control of both a crystal lattice plane and a nano-porous structure was attempted.

By combining a sol-gel method, in which surfactant micelles are used as templates of nano-pores, and a liquid phase epitaxial growth, a nano-porous BTO thin film with a controlled crystal lattice plane was successfully obtained. In addition, an ordered nano-porous structure was achieved by calcining the template consists of closely packed polystyrene nanoparticles after filling the precursor solution into the gaps.

Keywords : Nano-porous Materials, Organic Templates, Sol-gel Method, Liquid Phase Epitaxial Growth, Barium Titanate

チタン酸バリウム($BaTiO_3$: BTO)は 1940 年代に発見された古い強誘電体であるが、強誘電性・圧電特性・比誘電率のバランスが良く、鉛フリーの環境に優しい材料でもあるため、現在でも有用な強誘電体である。BTO の強誘電性は異方性があり、また、先行研究によりナノ細孔がもたらす結晶格子歪みにより、Curie 温度（相転移により強誘電性を失う温度）が上昇することを見いだしている [1), 2)]。そこで本研究では、ナノ多孔性 BTO 薄膜の強誘電性を最大限に引き出せるよう、結晶格子面とナノ細孔構造の制御を試みた。

界面活性剤ミセルをナノ細孔の鋳型に用いた sol-gel 法と液相エピタキシャル成長を組み合わせることで、結晶格子面が制御されたナノ多孔性 BTO 薄膜の合成に成功した。また、ポリスチレンナノ粒子を最密充填させた鋳型を準備し、隙間を前駆溶液で満たした後に鋳型除去を施すことで、規則的なナノ細孔構造を実現した。

1) Chemical Preparation of Ferroelectric Mesoporous Barium Titanate Thin Films: Drastic Enhancement of Curie Temperature Induced by Mesopore-Derived Strain, N. Suzuki *et al.*, *Chem. Eur. J* **2014**, *20*, 11283.

2) Origin of thermally stable ferroelectricity in a porous barium titanate thin film synthesized through block copolymer templating, N. Suzuki *et al.*, *APL Mater.* **2017**, *5*, 076111.