局所原子配列が可能な層状遷移金属酸化物のゾルゲル法による合成条件の探索

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Exploration of sol–gel synthesis conditions for layered transition-metal oxides with controllable local atomic arrangements ([1]*Tokyo Metropolitan University*) ○Tetta Tanonaka,[1] Hideyuki Kawasoko,[1] Soichi Kikkawa,[1] Seiji Yamazoe

Transition metal oxides have been extensively studied owing to their various physical properties, which can be tuned by controlling their chemical composition and local structure[1)]. Recently, our group reported that electrical resistivity of bulk polycrystalline samples of layered nickelate $Sr_{2.5}Bi_{0.5}NiO_5$, consisting of rock-salt-type $Sr_{1.5}Bi_{0.5}O_2$ layers and perovskite-type $SrNiO_3$ layers, can be significantly modulated by controlling the order and disorder states of Sr/Bi arrangement in the $Sr_{1.5}Bi_{0.5}O_2$ layers[2)]. Furthermore, more precise control of the degree of Sr/Bi ordering is expected to enable the further development of the physical properties. Indeed, for $Sr_{2.5}Bi_{0.5}NiO_5$ synthesized by solid-state reaction, the coexistence of multiple phases with different degrees of Sr/B ordering has been confirmed. However, the synthesis of single-phase samples with a uniform degree of Sr/B ordering has not yet been achieved.

In this study, aiming at the precise control of the degree of Sr/B ordering, we synthesized $Sr_{2.5}Bi_{0.5}NiO_5$ bulk polycrystals using sol–gel method, which is suitable for obtaining samples with highly homogeneous elemental distributions, and explored the synthesis conditions required to achieve high-purity $Sr_{2.5}Bi_{0.5}NiO_5$. In addition, we also attempted the sol–gel synthesis of $Sr_{2.5}Bi_{0.5}MO_5$ (M = Co, Fe, Mn, Cr), and reported these results together.

Keywords : Transition metal Oxide, Local atomic arrangement, Sol-gel method

遷移金属酸化物は、化学組成や局所構造の制御により多彩な物性を示すため、これまで盛んに研究されてきた[1)]。近年、我々のグループでは、岩塩構造の $Sr_{1.5}Bi_{0.5}O_2$ 層とペロブスカイト構造の $SrNiO_3$ 層からなる層状ニッケル酸化数 $Sr_{2.5}Bi_{0.5}NiO_5$ の多結晶バルク試料において、$Sr_{1.5}Bi_{0.5}O_2$ 層における Sr/Bi 配列の秩序・無秩序を制御することで、電気抵抗が大きく変調できることを報告した[2)]。さらに、Sr/Bi 配列の秩序度をより精密に制御できれば、さらなる物性の開拓が期待できる。実際、従来の固相反応法により合成された $Sr_{2.5}Bi_{0.5}NiO_5$ では、異なる秩序度を有する複数の相の存在が確認されているが、秩序度が均一な単相試料の合成には至っていない。

そこで本研究では、秩序度の精密制御をめざし、元素分布の均一性に優れた試料を得やすいゾルゲル法を用い、高純度の $Sr_{2.5}Bi_{0.5}NiO_5$ 多結晶バルク試料を得るための合成条件の探索を行った。さらに、$Sr_{2.5}Bi_{0.5}NiO_5$ に加えて、$Sr_{2.5}Bi_{0.5}MO_5$ (M = Co, Fe, Mn, Cr)についてもゾルゲル法による合成を試みたので、併せて報告する。

1) M. Imada *et al*., *Rev. Mod. Phys.* **1998**, *70*, 1039.
2) K. Matsumoto *et al., Adv. Sci.* **2023**, *10*, 2304978.