Epitaxial growth of $Bi_3O_2S_2Cl$ thin films with mist chemical vapor deposition

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Bismuth-based layered mixed anion compounds have been attracting much attention owing to their versatile functionalities. Recently, an n-type semiconductor $Bi_3O_2S_2Cl$ with an electrically conducting Bi–Cl layer was synthesized, exhibiting superconductivity by introducing sulfur vacancies [1]. However, the tens-micrometer-scale single crystals hampered electrical measurements. Therefore, thin film epitaxy is demanded for further investing various properties of this compound. In this study, we report first synthesis of $Bi_3O_2S_2Cl$ epitaxial thin films.

$Bi_3O_2S_2Cl$ thin films were synthesized on $(LaAlO_3)_{0.3}(SrAl_{0.5}Ta_{0.5}O_3)_{0.7}$ (LSAT) (100) and $SrTiO_3$ (100) single crystal substrates with hot-wall-type mist chemical vapor deposition [2]. In order to control the multi-element composition of the films, a mixture of the mists generated from two precursor N,N-dimethylformamide solutions of $BiCl_3$ and thiourea were supplied to the heated substrates by carrier N_2 and dilution O_2 gases (Fig. 1). The X-ray diffraction θ–2θ patterns showed only 00l diffractions of $Bi_3O_2S_2Cl$ thin films without any impurity peaks (Fig. 2). In reciprocal space mapping, 10$\underline{13}$ spot peak was observed, indicating successful growth of $Bi_3O_2S_2Cl$ (001) epitaxial thin films. To our knowledge, this is the first report of epitaxial thin film growth of oxyhalides containing three anions. Full width at half maximum of the rocking curves around 006 peak was as small as 0.23° and 0.13° for the films on LSAT and STO, respectively, indicating their good crystallinity. Electrical properties of the films are to be discussed in the presentation.

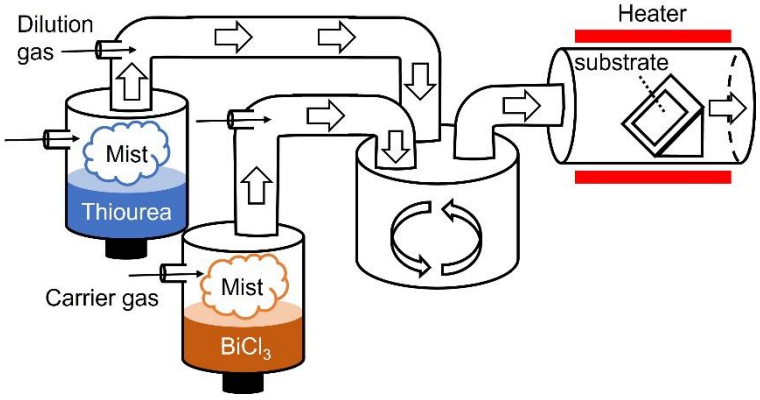

Fig. 1. Schematic image of mist chemical vapor deposition with two precursor solutions.

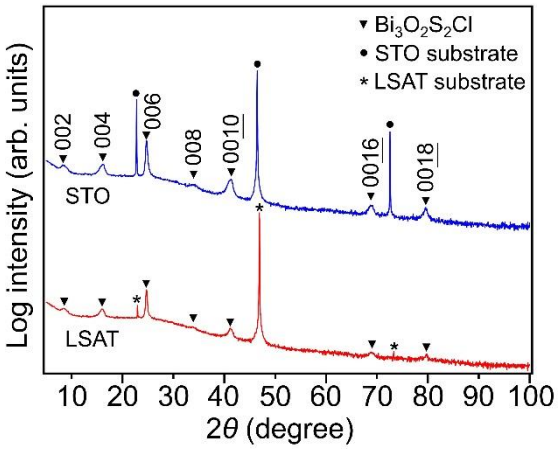

Fig. 2. X-ray diffraction θ–2θ patterns for $Bi_3O_2S_2Cl$ (001) epitaxial thin films on LSAT (100) and STO (100) substrates.

References

[1] B. Ruan *et al.*, J. Am. Chem. Soc. **141**, 3404 (2019). [2] Z. Sun *et al.*, Chem. Commun. **56**, 9481 (2020).