

Domain formations in heteroepitaxial lead titanate films fabricated by hydrothermal epitaxy below Curie temperature

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The +c-mono domain and a-domain formation in heteroepitaxial PbTiO₃ films fabricated by hydrothermal method at 200°C below Curie temperature (=490°C) were observed. At the early stage of the growth (≤ 1 h synthesis time), the islands with only the +c- mono domain with flat surface were formed. However, after this time, the islands were coalesced each other, and finally turned into the continuous film with thickness of ~ 500 nm. This continuous film had a small volume fraction of a-domains within the +c- mono domain matrix. It also had many small pyramids at the surface. The formation of the +c- mono domain shows that the positive polarization charges were strongly screened by the negatively charged surface layer at the film surface. It seems that the a-domains were formed as a result of the twinning of the tetragonal film that relaxes the strain energy due to both the thermal expansion coefficient, and lattice mismatch between the film and the substrate during cooling from 200°C. With finite element method (FEM) simulation, we will discuss the origin of the +c-mono domain formation and the mechanism of a-domain formation.

Keywords: ferroelectric domain formation, hydrothermal epitaxy

Synthesis of MoSi₂ and Mo₅Si₃ Intermetallic Compound by Mechanical Alloying

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Molybdenum silicides has come to be recognized as an attractive candidate material for high temperature structural applications. In this study, we applied mechanical alloying process to produce molybdenum silicides MoSi₂ and Mo₅Si₃ using a mixture of elemental molybdenum and silicon powders at room temperature. The intermetallic compound MoSi₂ have been obtained by ball milling of Mo₃₃Si₆₇ mixture powders for 100 h, which is transformed to single MoSi₂ phase by subsequent heat treatment up to 725°C. The grain size of the MoSi₂ powders thus obtained was 19 nm, being approximately four times smaller than that of the commercial alloy. The intermetallic compound Mo₅Si₃ with grain size of 30 nm have been also obtained by ball milling of Mo₆₂Si₃₈ mixture powders for 500 h, which is transformed to single Mo₅Si₃ phase by heating up to 1000°C. The finer grain size in the ball-milled molybdenum silicides powders is expected to improve room-temperature mechanical properties for high-temperature structural materials.

Keywords: mechanical alloying, molybdenum silicide, intermetallic compound, crystal structure, finer grain size, X-ray diffraction