Multi-Functional Materials Science

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【Staff Members】

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【Research Activities】

This laboratory is engaged in the development of new material and advanced material synthesis technique. As one of the results in the research of the structure and the ionic conduction for series of alkaline-earth ß-alumina, relationship between non-stoichiometric characteristics, the crystal structure and the ionic conduction of the Ba-ß alumina single crystal were clarified in thesis 1.

We discovered that $BaTi_2O_5$ single crystal synthesized by the FZ method have ferroelectricity for the first time in the world. In thesis 2, the reason for the appearance of ferroelectricity and the controllability of a dielectric characteristic by the element substitution was theoretically analyzed by using the first principle calculation.

In thesis 3, ittoria stabilization zirconia (YSZ) film by MOCVD had been made at the highest deposition speed in the world. And it reported on the nano-structure of the film and the possibility of the application as the thermal barrier coating.

Electric conductivity and the optical property of the IrO_2 film synthesized by the laser ablation were examined and the possibility as transparent conductive film of the IrO_2 film was shown in thesis 4.

We presented first report in the world for high-speed deposition of oxide films by laser-induced CVD in 2003. Thesis e reported on the following results of this study, the deposition mechanism of laser CVD and the possibility of the practical application as the thermal barrier coating for gas-turbine blade.

This group has originality and leading position at home and abroad for the development of the new material and the advanced material synthesis technique.

1. Electrical conductivity of nonstoichiometric Ba β-alumina single crystals prepared by a floating zone method,
A.Y. Zhang, T. Akashi and T. Goto
Solid State Ionics, 166 (2004) 77-82.

2. A lead-free high-Tc ferroelectric $BaTi_2O_5$: A first-principles study
U. Waghmare, M. H. F. Sluiter, T. Kimura, T. Goto and Y. Kawazoe,
Appl. Phys. Lett. 84 [24](2004) 4917-4919.

3. High-speed deposition of yttria stabilized zirconia by MOCVD,
R. Tu, T. Kimura, and T. Goto,
Surf. Coat. Tech. 187 (2004) 238-244.

4. Electrical and optical properties of IrO_2 thin films prepared by laser-ablation,
Y. Liu, H. Masumoto and T. Goto,
Mater. Trans. 45 10 (2004) 3023-3027.

5. High-speed deposition of zirconia films by laser-induced plasma CVD,
T. Goto,
Solid State Ionics 172 [1-4] (2004) 225-229.

【Plan】

This laboratory is continuously engaged in the development of new material and advanced material synthesis technique in 2005.

Our group succeeded in high-speed deposition of zirconia films by laser-assisted CVD for the first time in the world, and, we will develop this method further and apply to other oxide system materials. The research on nano structure and properties of the titanium oxide films as a photocatalyst material and the yttrium oxide films as a plasma etching-proof material further will be investigated.

We will improve the laser-assited CVD equipment for large scale coating, and promote the research for practical as thermal barrier coatings for gas-turbine blades.

Relationship between nano structure and property of multifunctional thin films based on noble metals by laser ablation and helicon sputtering will be clarified.

The zone melting method will be employed to develop new cerami ccomposites, mainly carbide and boride eutectic system composites, and then, the relation between structure and property will be clarified.

These composites will be applied to superhard materials.

A new ferroelectric material, $BaTi_2O_5$, discovered by our group modified by substituting Ba^{2+} and Ti^{4+} sites, and will be the relation between ferroelectric property and crystal structure will be studied.