

# ICC-IMR Activity Report 2008–2009

Multi-Functional Materials Science division, IMR, Tohoku Univ.

Takashi Goto

This activity report will show representative research and educational activities in the Multi-Functional Materials Science division (Goto lab) during 2008–2009.

**Visiting professor** Prof. Jorge Roberto Vargas Garcia (2009.2–2010.1; from National Polytechnic Institute, Mexico) demonstrated a high-speed feather-like growth of  $\text{CeO}_2\text{-FeO}$  films by laser CVD. Such film having high-specific surface area is advantageous to emission gas purification coatings [1-3].

**Research fellows** Prof. Guojun Li (2006.10–2007.9; Dalian Jiaotong Univ., China) reported that a pressure-less sintering can be used for preparation of  $\text{BaTi}_2\text{O}_5$  body, which is a promising material as a lead-free ferroelectric ceramics [4,5]. Dr. Yansheng Gong (2008.1–2009.3; China Univ. of Geosciences, China) studied on the high-speed deposition of TiN film by laser CVD as a hard coating material for cutting tools [6-8]. Dr. Chuanbin Wang (2005.8–2007.3; Wuhan Univ. of Technology, China), after he returned to China, he continued his work on the ferroelectric (020)-oriented  $\text{BaTi}_2\text{O}_5$  thin films prepared by laser ablation with us [9,10].

**Graduated students** Fengping Lai (2006.10–2008.3; Tsinghua Univ., China) successfully got her M.Eng in the double-degree program of Tohoku Univ. with Tsinghua Univ. by her study on the ferroelectric  $\text{NaKNbO}_3$  thin film [11]. Xinyan Yue (2005.4–2008.3; Northeastern Univ., China) and Nittaya Keawprak (2006.4–2009.3; Thailand Institute of Scientific and Technological Research, Thailand) defended their Ph.D. from Tohoku Univ. After they returned to their country, they developed the studies with us as a collaborative research [13-21]. Ipek Akin (2008.1–2008.7; National Polytechnic Institute, Mexico) studied on the spark plasma sintering of  $\text{ZrB}_2\text{-SiC}$  composite for high-temperature structural material [22]. Dr. Hotta took a research grant from JSPS and conducts collaborative research. Hye-Sook Joo (2009.8–2010.1; Yonsei Univ.) studied on the TiON film by laser CVD.

**Collaborative research** We have worked closely with Wuhan University of Technology, China through a lot of collaboration [23]. Dr. Dongyun Guo carries out the collaborative research on the ferroelectric Ba-Ti-O films prepared by laser CVD with the support of A3 Foresight Program, JSPS, and International Science and Technology Cooperation Program of China, Ministry of Education of China (Grant No. 2009DFB50470). Prof. Jow-Lay Huang (National Cheng Kung Univ., Taiwan) provides their  $\text{Al}_2\text{O}_3$  and  $\text{Si}_3\text{N}_4$  powders to us, and the spark plasma sintering is conducted by our lab. Collaboration is still going on and his student is planning to study at our lab next summer.

**Organized conferences** Prof. Takashi Goto organized the 1st International Symposium on Advanced Synthesis and Processing Technology for Materials (ASPT08; Nov. 14–17, 2008, China) as a conference chairman with Wuhan Univ., China and Monash Univ., Australia. The conference attracted much attention and favorably featured in the China Daily [24]. He also organized international symposia on “Nano-Bio and Amorphous Materials (Aug. 7–8, 2008)” and “Nano/Amorphous Materials and Interface Science (Aug. 7–8, 2009)” supported by the Japan-Korea Asian Core Program, JSPS.



The China Daily reported successful launch of the international scientific collaboration at the conference.

# Accomplishment report

## Original papers

1. Jorge Roberto Vargas Garcia, Rong Tu and Takashi Goto: Highly (100)-oriented CeO<sub>2</sub> films prepared on amorphous substrates by laser chemical vapor deposition, *Thin Solid Films*, submitting.
2. Jorge Roberto Vargas Garcia, Rong Tu and Takashi Goto: CeO<sub>2</sub> films deposited by laser CVD, in preparation.
3. Jorge Roberto Vargas Garcia and Takashi Goto: Catalytic materials prepared by chemical vapor deposition, *Materials Science and Engineering*, submitting.
4. Guojun Li, Rong Tu and Takashi Goto: Preparation of polycrystalline BaTi<sub>2</sub>O<sub>5</sub> ferroelectric ceramics, *Materials Letters*, 63 (2009) 2280-2282.
5. Guojun Li, Rong Tu and Takashi Goto: Effect of ZrO<sub>2</sub> addition on preparation of polycrystalline BaTi<sub>2</sub>O<sub>5</sub> by pressureless sintering, *Materials Research Bulletin*, 44 (2009) 468-471.
6. Yansheng Gong, Rong Tu and Takashi Goto: Laser chemical vapor deposition of titanium nitride films with tetrakis (diethylamido) titanium and ammonia system, *Surface Coatings and Technology*, accepted.
7. Yansheng Gong, Rong Tu and Takashi Goto: Effect of NH<sub>3</sub> on the preparation of TiN<sub>x</sub> films by laser CVD using tetrakis-diethylamido-titanium, *Journal of Alloys and Compounds*, 485 (2009) 451-455.
8. Yansheng Gong, Rong Tu and Takashi Goto: Microstructure and preferred orientation of titanium nitride films prepared by laser CVD, *Materials Transaction*, 50 (2009) 2028-2034.
9. Chuanbin Wang, Rong Tu, Takashi Goto, Qiang Shen and Lianmeng Zhang: Structural and optical properties of BaTi<sub>2</sub>O<sub>5</sub> thin films prepared by pulsed laser deposition at different substrate temperatures, *Materials Chemistry and Physics*, 113(1) (2009) 130-134.
10. Chuanbin Wang, Rong Tu, Takashi Goto, Qiang Shen and Lianmeng Zhang: Preparation of b-axis oriented BaTi<sub>2</sub>O<sub>5</sub> thin films by pulsed laser deposition, *Journal of Inorganic Materials*, 23(3) (2008) 553-556.
11. Fengping Lai, Rong Tu, Takashi Goto and Jingfeng Li: Characterization of ferroelectric Na<sub>x</sub>K<sub>1-x</sub>NbO<sub>3</sub> system films prepared by pulsed laser deposition, *Materials Transaction*, 49(9) (2008) 2076-2081.
12. Jianfeng Zhang, Leifeng Liu, Lianjun Wang, Wan Jiang, Lidong Chen, Rong Tu and Takashi Goto: Microstructures and mechanical properties of TiN-TiB<sub>2</sub>-Ti<sub>5</sub>Si<sub>3</sub> composites in-situ fabricated by spark plasma sintering, *Journal of the Ceramic Society of Japan*, 117(10) (2009) 1085-1088.
13. Xianyan Yue, Rong Tu and Takashi Goto, Dielectric properties of Ba<sub>1-x</sub>Ca<sub>x</sub>Ti<sub>2</sub>O<sub>5</sub> prepared by arc melting, *Materials Transaction*, 50(2) (2009) 245-248.
14. Xianyan Yue, Rong Tu and Takashi Goto: Dielectric property of poly- and single-crystalline BaTi<sub>2</sub>O<sub>5</sub> co-substituted with SrO and ZrO<sub>2</sub>, *Key Engineering Materials* 388 (2009) 217-220.
15. Xianyan Yue, Rong Tu and Takashi Goto: Dielectric properties of (010) oriented Ta<sub>2</sub>O<sub>5</sub> substituted BaTi<sub>2</sub>O<sub>5</sub> prepared by arc melting, *Journal of the Ceramic Society of Japan*, 116(3) (2008) 436-440.

16. Xianyan Yue, Rong Tu and Takashi Goto: Dielectric property of polycrystalline  $ZrO_2$  substituted  $BaTi_2O_5$  prepared by arc-melting, *Materials Transaction* 49(1) (2008) 120-124.
17. Xianyan Yue, Rong Tu, Takashi Goto and Hongqiang Ru: Effect of alkaline earth oxides on dielectric properties of polycrystalline  $BaTi_2O_5$  prepared by arc melting, *Ceramic Transactions*, to be published.
18. Nittaya Keawprak, Rong Tu and Takashi Goto: Thermoelectric properties of alkaline earth ruthenates prepared by SPS, *Materials Science and Engineering B*, 161 (2009) 71-75.
19. Nittaya Keawprak, Rong Tu and Takashi Goto: Thermoelectric properties of Ca-Ir-O compounds prepared by spark plasma sintering, *Materials Transaction*, 50(4) (2009) 853-858.
20. Nittaya Keawprak, Rong Tu and Takashi Goto: Thermoelectricity of post-perovskite  $CaIrO_3$  prepared by spark plasma sintering, *Journal of the Ceramic Society of Japan*, 117 (2009) 466-469.
21. Nittaya Keawprak, Rong Tu and Takashi Goto: Thermoelectric properties of Sr-Ru-O compounds prepared by spark plasma sintering, *Materials Transaction*, 49(3) (2008) 600-604.
22. Ipek Akin, Mikinori Hotta, Filiz Cinar Sahin, Onuralp Yucel, Gultekin Goller and Takashi Goto Microstructure and densification of  $ZrB_2$ -SiC composites prepared by spark plasma sintering, *Journal of the European Ceramic Society*, 29(11) (2009) 2379-2385.

#### **Press reporting**

23. Recent Academic Exchange between Tohoku University and China, *Science Portal China* (April 20, 2009), [http://www.spc.jst.go.jp/exchange/rondan/nr09\\_003.html](http://www.spc.jst.go.jp/exchange/rondan/nr09_003.html)
24. ASPT08 SPECIAL REPORT, *China Daily* (March 13, 2009).