Fabrication of PZT Thin Film from Halogen-Free Aqueous PZT Precursor Solution

Takashi Miwa[1], Osamu Sakurada[1], Minoru Hashiba[1], Yasutaka Takahashi[2]
[1]*Department of Material Science and Technology, Gifu University, Gifu, 501-1193, Japan*
[2]*Daiken Chemical Co. Ltd., Osaka, 536-0011, Japan*
Phone (058) 293-2574
E-mail: sakurada@apchem.gifu-u.ac.jp
http://mast.gifu-u.ac.jp/˜mp3/

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Introduction

Lead zirconate titanate (PZT, $Pb(Zr_{0.5}Ti_{0.5})O_3$) thin films are especially well known materials because of their remarkable dielectric, piezoelectric, ferroelectric and photoelectric properties. In this study, PZT ferroelectric thin films were successfully deposited on ITO coated glass substrates by multiple spin-coating technique. A precursor solution of PZT was composed of aqueous titanate solutions, aqueous lead acetate solution and aqueous zirconium acetate solution. The aqueous titanate solution used in this study was prepared by mixing titanium alkoxide (titanium tetra-*iso*-propoxide (TIP) or titanium tetra-*n*-butoxide (TNB)), lactic acid (Lac) and water[1)]. The solution seems to be very valuable as the starting material for another titanium compounds including titanium oxide because they would have higher titanium content and lower carbon dioxide emission on firing process. In addition, the titanate solution is very stable for a long time in air and free from hazardous halogen, nitrogen, sulfur, and metal ions other than titanium. The advantages of this aqueous route are controllable composition which can be effected by mixing the constituents at a molecular level in solution and free from hazard molecules such as halogen, nitrogen, and sulfur.

Methods

Aqueous titanate solution (TIP-Lac or TNB-Lac) was prepared by directly mixing TIP or TNB with Lac and water at room temperature. And then exothermic reaction instantly occurred to give a white solid mass. The solid product was gradually dissolved under stirring and a clear solution for a few days. The molar ration of Lac to TIP or TNB was 1. To prepare PZT precursor solution, TIP-Lac or TNB-Lac, aqueous lead acetate solution, and aqueous zirconium acetate solution were mixed in molar ratio Pb : Zr : Ti = 2 : 1 : 1. The thin films were obtained from the PZT precursor solution *via* spin-coating method. The films were dried at 180 ºC for 10 min and then heated at various temperatures for 30 min. Thicker films were prepared by repeating the deposition cycle. The thin PZT films were characterized by XRD, SEM observation and dielectric measurements.

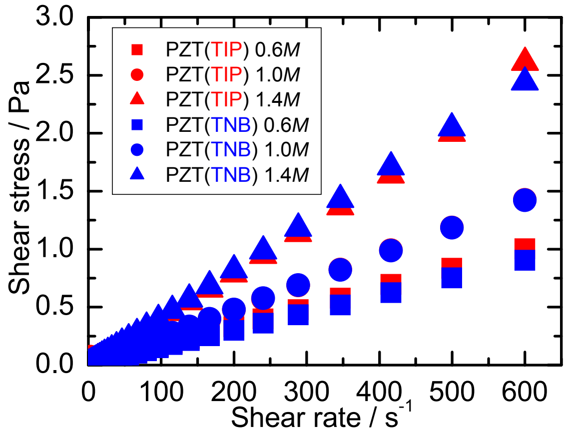


Fig. 1. Rheological behaviors of the PZT precursor solutions.

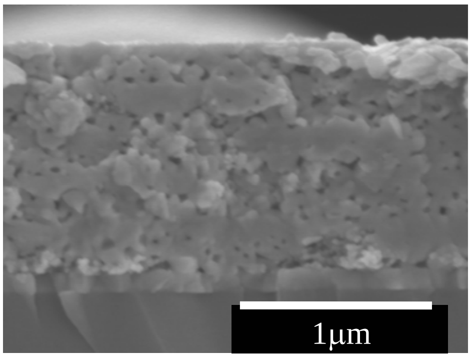


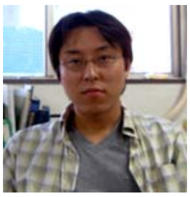
Fig. 2. SEM image of PZT thin film on ITO substrate using PZT(TIP) precursor

Results and Discussion

Figure 1 shows that the shear stress versus shear rate curves for the PZT precursor solutions. The rheological behaviors of the PZT precursor solutions showed Newtonian flow and the viscosity of the PZT solution was increased with increasing concentration of PZT solution. The results of XRD showed that PZT perovskite phase was obtained after heating above 650°C in air and the crystalline size became larger with increasing heating temperature. The scanning electron micrograph of the cross-section of a PZT thin film deposited on ITO glass substrate is shown in Fig. 2. The PZT thin film was dense and perovskite single phase. Dielectric constant for PZT (TIP) thin film was around 650 at 1 kHz.

1) T. Ohya, et al., *J. Sol-Gel Sci. Tech.*, **30**, 71-81 (2004).

About Myself



Name: Takashi Miwa
Nationality: Japanese
Hometown: Ogaki, Gifu, Japan
Hobby: Music (Playing Violoncello (Cello))
< I belong to the Orchestra of Gifu University. >
Watching Baseball Games
Favorite Team: Chunichi Dragons
Favorite Artist: Johannes Brahms, Antonín Leopold Dvořák
Favorite Food: Curry, Oyster, Chocolate
Now Playing Game: Romancing SaGa -Minstrel Song