$BiFeO_3$-$PrFeO_3$-$PbTiO_3$계의 강자성-강유전 특성

Ferroelectric and ferromagnetic properties of $BiFeO_3$-$PrFeO_3$-$PbTiO_3$ solid solutions

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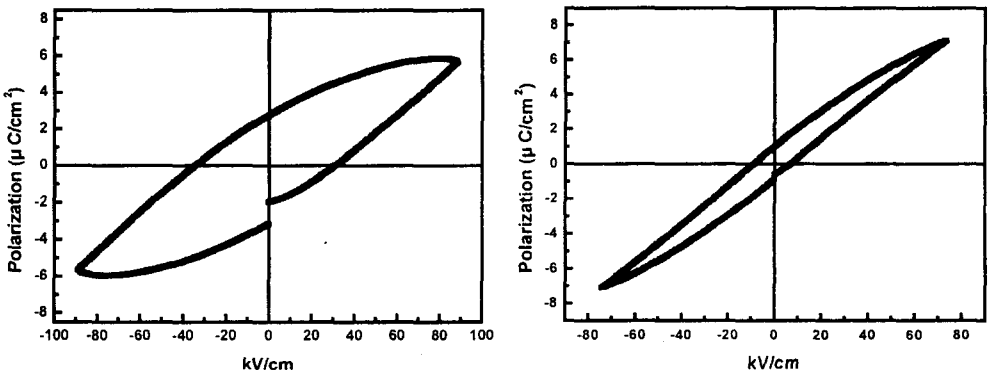
Synthesis of the ferroelectromagnetic material exhibiting ferromagnetism and ferroelectricity simultaneously has been an interesting subject due to not only for a possible application in electronic devices but also from the view point of solid state physics. In this study bulk ceramics and thin films of $xBiFeO_3$-$yPrFeO_3$-$zPbTiO_3$ ($x + y + z = 1$) and $(1 - w)BiFeO_3$-$wPbTiO_3$ have been explored for finding ferroelectromagnetic material, in which ferroelectricity and ferromagnetism coexist simultaneously. Ferroelectric and/or antiferromagnetic end members have been combined for the purpose of achieving both high electrical resistivity and spontaneous magnetization. Hysteresis curves of P-E and M-H at RT have been measured using RT66A ferroelectric tester of Radiant Technologies and VSM (vibrating sample magnetometer) respectively. Magnetization behavior at low temperature (10K ~ 300K) was tested using a SQUID magnetometer. The X-ray diffraction data were obtained at room temperature using a MacScience M18XHF diffractometer. Neutron diffraction data were obtained in the temperature range of 10K ~ 300K using HRPD diffractometer at HANARO in KAERI (Korea Atomic Energy Research Institute). The crystal structure was analysed by the Rietveld profile refinement method using a version 3.2 of the program Fullprof.

The coexistence has been observed only in some ternary composition samples i.e., $0.2BiFeO_3$-$0.2PrFeO_3$-$0.6PbTiO_3$ and $0.4BiFeO_3$-$0.2PrFeO_3$-$0.4PbTiO_3$. The ternary solid

solutions become paramagnetic with the decrease of $PrFeO_3$ content to $y < 0.2$ independently of $BiFeO_3$ content. When $PrFeO_3$ content remains constant at $y = 0.2$, the ternary solid solutions become paraelectric with the decrease of $PbTiO_3$ content to $z \leq 0.2$. The ferroelectromagnetic solid solutions have the noncentrosymmetric and doubled perovskite unit cell with a space group I4cm ($a = b \approx 5.4$Å, $c \approx 7.9$Å). Addition of Ta_2O_5 dopant substantially changes the P-E and M-H curves of the $0.2BiFeO_3$-$0.2PrFeO_3$-$0.6PbTiO_3$. The binary solid solutions of (1 - w)$BiFeO_3$-w$PbTiO_3$ are paramagnetic down to 10K over the entire composition range.



(a) Ta_2O_5 = 0.005 mole (b)Ta_2O_5 = 0.0075 mole

Fig. 1. Effect of Ta_2O_5 additions on P-E curves of the 226.

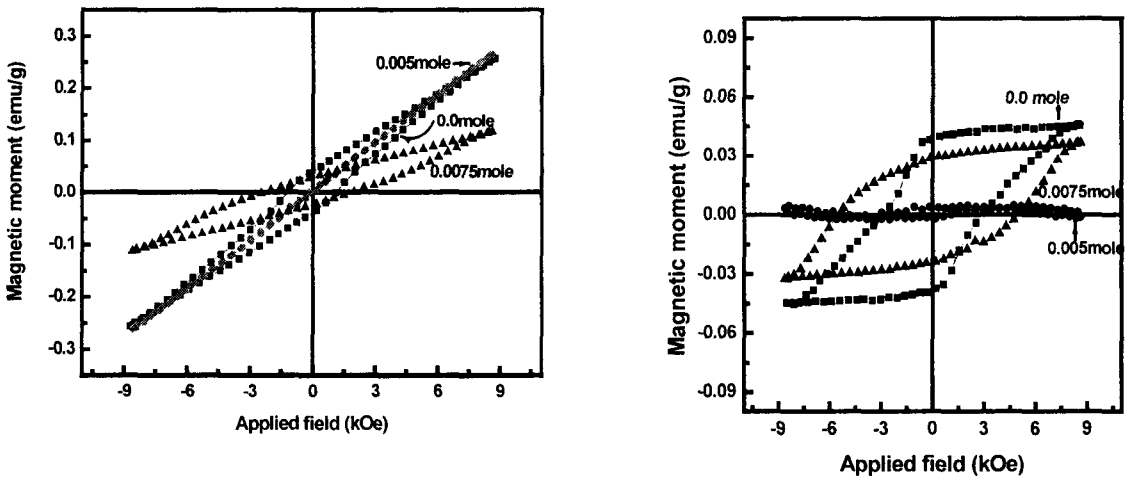


Fig. 2. . Effect of Ta_2O_5 addition (0, 0.005, 0.0075mole) on M-H curves of the 226 sample at RT.