Electron-Spin-Resonance study of Ball Milled $BaTi_{0.98}Mn_{0.02}O_3$ Nanocrystalline

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Due to its large band gap (around 3.2 eV), Barium titanate ($BaTiO_3$) was considered as not only an important ferroelectric and piezoelectric material, but also a good candidate for dilute magnetic semiconductors (DMS). Nakayama and Katayama Yoshida in 2001 theoretically predicted that ferromagnetic properties can be obtained by doping some TM ions such as Cr, Mn, and Fe in $BaTiO_3$. Recently, Ferromagnetic properties in BaTiO3 based materials have been reported by many research groups, leading to a bright prospect of application in spintronics devices in the future. However, the origin of ferromagnetic property is still controversial. It has been found that various energetically metastable defects strongly influence the charge carrier density, and the oxygen vacancies were also supposed to play a crucial role in ferromagnetism in DMS.

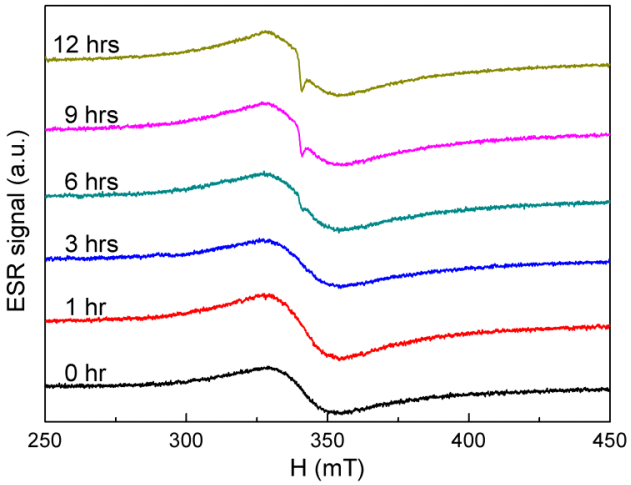

Fig. 1: Room-temperature ESR spectra of $BaTi_{0.98}Mn_{0.02}O_3$ with different milling times.

To discover the intrinsic ferromagnetic originin $BaTiO_3$ system, electron-spin-resonance (ESR) study of ball milled $BaTiO_3$ with 2 at.% Mn doping polycrystalline ceramics wasperformed in this work. Samples were prepared from conventional solid reaction method with a sintering temperature of 1000 °C, then put into mechanical ball milling for various milling time of 1 hr, 3hrs, 6hrs, 9hrs, and 12 hrs, respectively. The ESR measurement were carried out at 9.45GHz (X-band) using a JEOL-TE300 ESR spectrometer. The Room-temperature ESR spectra were shown in Fig. 1. It is clear to see the two types of signal in the spectra, one is the broad linewidth signal which originate from the Mn ions incorporated into the Ti site of the $BaTiO_3$ host lattice, and they are considered as paramagnetic centers. The other one is the sharp peak located around 340 mT which was believed to be from the oxygen vacancy defects generated during the milling.