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Magnetic tunnel junctions with $L1_0$-ordered FePd electrode

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There has been growing interest recently in spin transfer torque magnetic random access memory (STT-RAM) using perpendicularly magnetized magnetic tunnel junctions (*p*-MTJs) because of advantages for both better scalability and higher storage density. From the viewpoint of device reliability of STT-RAM, it is necessary to realize small critical switching current and high thermal stability [1, 2]. The problem of thermal fluctuation of magnetization has become a general issue in nanometer-scale magnetic devices. $L1_0$ ordered FePd is a candidate ferromagnetic material that can overcome this problem because the high magnetocrystalline anisotropy energy. There are few works on the preparation and investigation of the structure and magnetic properties in $L1_0$-ordered FePd films have been performed to date [3, 4]. However tunnel magnetoresistance has never been examined in MTJs and granular film including $L1_0$-ordered FePd alloys due to some difficulty in preparation of highly ordered $L1_0$- FePd alloys in the film state. To achieve the status of truly next-generation technology, bit cell size of MTJs has to be reduced to the submicron dimension or smaller. The FePd electrode for the free bottom layer of the MTJs in our previous study was reported and CoFeB layer was inserted between $L1_0$-FePd and MgO barrier for the reduction of the thickness of free layer as well as for lowering the switching current density [5]. The annealing effect on PMA and $L1_0$ order parameter of FePd/CoFeB/MgO trilayer was systematically investigated in another report for the further reduction of the thickness of the free layer of MTJs [6]. We obtained PMA~7 Merg/cc for 2.0 nm thick FePd with annealing at 350°C. In this study, the top reference layer was optimized for the fabrication of MTJs. For the investigation of the top reference layer to fabricate MTJ, we inserted a pinning layer of CoFeB between MgO and FePd to increase the interfacial spin polarization remaining high PMA. We obtained PMA~5 Merg/cc for FePd film of 15.0 nm with CoFeB (0.5 nm) pinning layer on MgO buffer. MTJs were fabricated successfully using the $L1_0$-FePd bottom electrode obtained in our previous experiment. TMR and related properties of the MTJs have been investigated.

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