Ultrafast Optical Manipulation of Magnetization Reversal in (Ga,Mn)As

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(Ga,Mn)As is a prototype diluted magnetic semiconductors that can be potentially used in spin-based devices [1,2]. The biaxial magnetic anisotropy would lead to an optical manipulation of four-state magnetic reversal due to the giant magnetic linear dichroism observed in (Ga,Mn)As [3]. The dynamic process of four-state magnetization reversal in a 200nm-thick (Ga,Mn)As film has been investigated at 8 K by Time-resolved magneto-optical Kerr effect (TR-MOKE) measurement. The magnetization reversal was dramatically reduced by pump pulsed laser, and recovered slowly with time evolution (Fig. 1). The coercive fields ($H_{c1}$) increase abruptly from 30 Gauss to 108 Gauss on the first several picoseconds after pump excitation and then recover back to the value before pumping within 550 ps (Fig. 2). While $H_{c2}$ didn’t change obviously due to the pinning effect of defects in (Ga,Mn)As on domain wall energy. The M-shaped hysteresis loops collapse when temperature increases close to half of $T_c$, which agrees well with the temperature dependence of magnetic anisotropy transition[4] (see inset of Fig. 2). The observation can be well explained by the light-induced magnetic anisotropy changes and hole enhanced domain wall energy. The magnetic switch occurs for pump fluences of only ~2 $\mu$J/cm², which is five orders of magnitude lower than that achieved by Astakhov et al.[5]. The observations show that (Ga,Mn)As has promising application in ultra-fast magneto-optical memory devices.