Electric-Field Control of Faraday Rotation in ultra-thin Ferromagnetic Material

○日比野有岐[1]、小山知弘[1]、三輪一元[2]、小野新平[2]、好田誠[3]、千葉大地[1]
（1. 東大物工, 2. 電力中央研究所 3. 東北大）
Y. Hibino[1], T. Koyama[1], K. Miwa[2], S. Ono[2], M. Kohda[3], and D. Chiba[1]
(1. The Univ. of Tokyo, 2. CRIEPI, 3. Tohoku Univ.)
Email: 3495814938@mail.ecc.u-tokyo.ac.jp

After a linear polarized light penetrates through magnetized materials, its polarized plane rotates, which is known as the Faraday Effect. Conventionally, the control of Faraday rotation angle was done by applying external magnetic field. In this work, we show that the Faraday rotation in MgO/Co/Pt structure can be controlled not only with the magnetic field but with the electric field effect on magnetism [1,2].

Multilayer structure consisted of Ta(2.7)/Pt(2.0)/Co(0.38)/MgO(2.0) was deposited on the glass substrate by using rf sputtering. Inside the bracket shows the thickness of each layer in nanometer. A polymer film containing ionic liquid was attached on the sample to apply large electric field to the sample due to the formation of the electric double layer (EDL) at the surface. Measurement of the Faraday Effect was performed using Photo Elasticity Modulation (PEM) technique. Figure 1(a) shows the perpendicular magnetic field dependence of the voltage signal proportional to the Faraday rotation angle (V_F). A clear change from square hysteresis loop to linear response was obtained by changing the gate voltage (V_G). One possible cause of this change is the ferromagnetic phase transition of Co induced by the electric field as demonstrated in the previous report [1,2]. Figure 1(b) shows the time charts of V_G and V_F. One can see that V_F increased and decreased along with V_G, indicating that the Faraday rotation switching mediated from electric-field modulation of magnetism was reversible. The method shown here offers completely new concept for electrically switching of optical property as well as opening a new windows for realizing a fast and eco-switching of it.

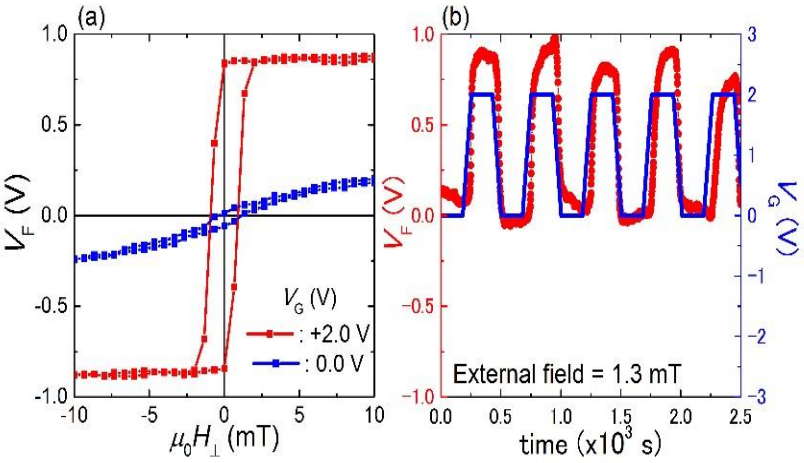

Figure: Perpendicular field ($\mu_0 H_\perp$) dependence of the V_F under the application of the gate voltage (V_G) of +2 and 0.0 V (a). The V_G induced switching cycles of V_F (b).

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