Ultrafast Enhancement of Interfacial Exchange Coupling in Ferromagnetic Co_2FeAl/(Ga,Mn)As Bilayer

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Fast spin manipulation in low-dimensional magnetic heterostructures, where magnetic interactions between different materials often define the functionality of devices, is a key issue in the development of ultrafast spintronics. Although recently developed optical approaches such as ultrafast spin-transfer and spin-orbit torques open new pathways to fast spin manipulation, these processes do not utilize the unique possibilities offered by interfacial magnetic coupling effects in ferromagnetic multilayer systems. Here, we experimentally demonstrate ultrafast photoenhanced interfacial exchange interactions in the ferromagnetic Co_2FeAl/(Ga,Mn)As system at low laser fluence levels [1]. The excitation efficiency is 30-40 times higher than without the (Ga,Mn)As layer due to *p-d* exchange interaction between photoexcited holes and Mn spins (Fig. 1). The coherent spin precessions persist to room temperature, indicating that proximity-induced ferromagnetism plays a key role in the optical excitation mechanism. The results highlight the importance of considering the range of interfacial exchange interactions in low-dimensional heterostructures and how these magnetic coupling effects can be utilized for ultrafast, low-power spin manipulation.

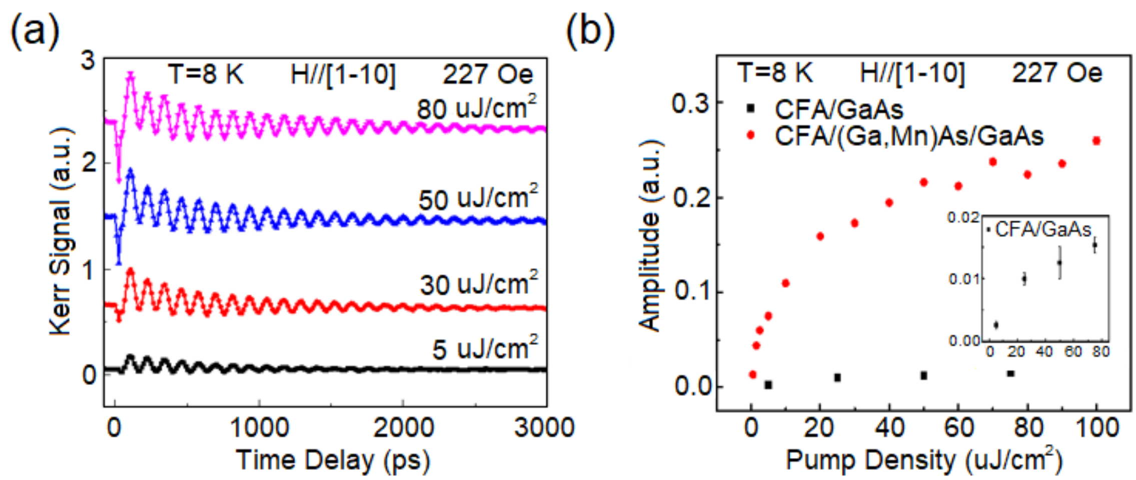

Figure 1: (a) TRMOKE results from Co_2FeAl/(Ga,Mn)As bilayer at 8 K with *H* applied along hard axis [1-10] for different pump-energy densities. (b) Precession amplitude as a function of pump-energy density for Co_2FeAl/(Ga,Mn)As (red dots) and Co_2FeAl/GaAs (black dots), respectively.

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