Abstract of Presentation

Presentation Title:

Current-induced magnetization dynamics in nano-magnet: fundamental to applications

Abstract :

The manipulation of magnetization by spin currents is a key technology for future spintronics. The underlying physics is that spin currents can apply a torque on the magnetic moment when the spin direction of the conduction electrons has a relative angle to the local magnetic moment. This leads us to a general concept that any type of spin structure with spatial variation can be excited by a spin-polarized current in a ferromagnet. We confirmed this concept for two typical noncollinear spin structures: magnetic domain wall (DW) and magnetic vortex.

The direction of magnetic moments gradually changes in a DW. Since the spin direction of conduction electrons changes when the electrons cross the DW, spin transfer from electrons to the DW occurs and torque is exerted on the DW. In consequence, an electric current can displace the DW. This current-driven DW motion is now investigated extensively, since in addition to exciting fundamental physics, novel applications based on this phenomenon have been proposed. We show that a single current pulse can control precisely the DW position from notch to notch in a Co/Ni wire with perpendicular magnetic anisotropy.

The spin transfer torque is also expected to be active in a magnetic vortex, in which a curling magnetic structure with a nanometer-scale core is realized. We show that a magnetic vortex core in a ferromagnetic circular dot can be resonantly excited by an ac current through the dot when the current frequency is tuned to the resonance frequency originating from the confinement of the vortex core in the dot. The core is efficiently excited by the ac current due to the resonant nature and the resonance frequency is tunable by the dot shape. We also demonstrate that the direction of a vortex core can be switched by ac current or by a single nano-second current pulse. Three-terminal device based on the current-induced magnetic vortex dynamics that can act as a resonant transistor is also presented.