Cooperative Spintronics Research For Beyond CMOS

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The talk will discuss our spintronics work, which is being performed in the Western Institute of Nanoelectronics (WIN) and the MARCO Focus Center on Functional Engineered Nano Architectonics (FENA). The objective of our work is to address the use of spin as a state variable and to study the feasibility and the implementation of spin-based devices for nanoelectronic applications in order to resolve the major challenges in power dissipation and variability issues. In this talk, we will first discuss the scaling of spintronics and electronics in terms of power dissipation and variability issues. We will describe some examples of spintronics materials, both metallic materials and dilute magnetic semiconductors, for creating new spin-based building blocks. For metallic nanomagnetism work, spin dynamics of nanomagnets will also be discussed. A spin wave bus concept using ferromagnetic films will be discussed for logics and information transfer; the characterization of the spin wave propagation in a ferromagnetic thin film as a function of frequency will be reported. The details of the material properties are obtained from the frequency dispersion data of these studies. Other principles of nano spin-based devices such as spin torque devices will also be discussed for information processing and storage.

We will also discuss the on-going work on dilute ferromagnetic materials and devices, e.g., MnGe (MnSi) for potential of logic device applications. The research includes material preparation by ion implantation and molecular beam epitaxy, and material characterization by X-ray and TEM from these two different approaches. The paramagnetic to ferromagnetic transition as a function of the hole density is demonstrated. In addition, the electric field dependence in a MOS structure indicates that the magnetic transition may be controlled by electric field and by the carrier density.

This work illustrates an example of cooperative long-term basic research under the partnership of industry, government and academia to address focus areas of industrial interest: in this case, spintronics.