IMPLEMENTATION OF SILICON NATIVE OXIDE AS A TUNNEL BARRIER FOR SPINTRONICS

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The integration of ferromagnetic and semiconductor materials offer unique possibilities to develop a powerful and reliable method of injecting and detecting spins in the semiconductor material at room temperature. However a strong obstacle for the development of this technology is associated with the large impedance mismatch existent between both types of materials, which limits the spin injection from high conductive ferromagnetic material to high-resistive non-magnetic semiconductor. The use of extremely thin tunnel barriers has been recently proved to be the solution to this problem [1,2]. The use of SiO2 as a barrier is very promising due to its high dielectric constant. However the main problem concerns with the difficulty in stabilizing extremely thin layers of SiO2 on silicon substrates while deposition of the ferromagnetic material.

Within this context, we have successfully grown thin layers of Fe_3O_4 on Si/SiO_2 substrates by PLD, with thicknesses ranging between few nm to 80 nm, in order to determine the applicability of FM-semiconductor integration using SiO_2 native oxide as a tunnel barrier. A complete morphological, compositional, electronic, magnetic and transport characterization has been performed by synchrotron based X-ray reflectivity, high and low energy XPS, Raman spectroscopy, SEM, Magneto-Optic Kerr effect and in-plane transport techniques. Special attention has been paid on the quality of the buried interfaces, thickness of the tunnel barrier and absence of other iron oxide phases or silicate phases. The results showed Fe_3O_4 single phase character without silicate formation, ferromagnetism at room temperature, well-defined metal to insulator transition, high quality interfaces and low tunnel barrier thicknesses.

Keywords: Tunnel barrier; Spintronics.

References

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