Epitaxial Growth and Structural Characterization of Mgo-Based Magnetic Tunnel Junctions and Ferromagnetic/Mgo/Semiconductor Heterostructures

Y. F. Chiang, Y. Li, K. Pi, X. Tan, H. Tom and R. K. Kawakami*
Department of Physics and Astronomy, University of California, Riverside, CA 92521

MgO-based magnetic tunnel junctions (MTJ) are a strong candidate for next generation magnetic random access memory (MRAM) due to the observation of large tunneling magnetoresistance (TMR) and spin-torque switching for read and write operations, respectively. Ferromagnetic/MgO/semiconductor heterostructures are possible building blocks for semiconductor spintronic devices. In this poster, we will present the growth, magnetic, and magnetotransport properties of Fe/MgO/Fe tunnel junctions, Fe/MgO/Ge heterostructures, and Fe/MgO/GaAs heterostructures. We have developed three different methods for depositing MgO: (1) evaporation of Mg in oxygen atmosphere, (2) direct e-beam heating of MgO, (3) evaporation from heated Ta crucible. For the MgO-based magnetic tunnel junctions, we have fabricated magnetic tunnel junction devices by shadow masks and measured TMR, and utilized the second harmonic generation (SHG) to probe the Fe/MgO interfaces. Our goal is to develop an understanding of TMR (especially the role of interfaces), increase the value of TMR, and to optimize the properties of spin-torque to help reduce the critical current densities needed to write magnetic bits. For the ferromagnetic/MgO/semiconductor, we have successfully grown atomically flat MgO on Ge(100) substrates and interestingly found out that the flatness of MgO grown on GaAs is strongly dependent on the growth rate of MgO.

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*Corresponding Author.
Email Id: roland.kawakami@ucr.edu[Roland Kawakami]