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Giant tunnelling magnetoresistance at room temperature with MgO (100) tunnel barriers

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SSP Parkin, C Kaiser, A Panchula, PM Rice, B Hughes, M Samant, SH Yang

Nature materials, 2004 • nature.com

Abstract

Magnetically engineered magnetic tunnel junctions (MTJs) show promise as non-volatile storage cells in high-performance solid-state magnetic random access memories (MRAM). The performance of these devices is currently limited by the modest (<~70%) room-temperature tunnelling magnetoresistance (TMR) of technologically relevant MTJs. Much higher TMR values have been theoretically predicted for perfectly ordered (100) oriented single-crystalline Fe/MgO/Fe MTJs. Here we show that sputter-deposited polycrystalline MTJs grown on an amorphous underlayer, but with highly oriented (100) MgO tunnel barriers and CoFe electrodes, exhibit TMR values of up to ~220% at room temperature and ~300% at low temperatures. Consistent with these high TMR values, superconducting tunnelling spectroscopy experiments indicate that the tunnelling current has a very high spin polarization of ~85%, which rivals that previously observed only using half-metallic ferromagnets. Such high values of spin polarization and TMR in readily manufactureable and highly thermally stable devices (up to 400 °C) will accelerate the development of new families of spintronic devices.

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