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Symmetric and Asymmetric Magnetic Tunnel Junctions with Embedded Nanoparticles: Effects of Size Distribution and Temperature on Tunneling Magnetoresistance and Spin Transfer Torque

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Abstract

© 2017 The Author(s). The problem of the ballistic electron tunneling is considered in magnetic tunnel junction with embedded non-magnetic nanoparticles (NP-MTJ), which creates additional conducting middle layer. The strong temperature impact was found in the system with averaged NP diameter d av < 1.8 nm. Temperature simulation is consistent with experimental observations showing the transition between dip and classical dome-like tunneling magnetoresistance (TMR) voltage behaviors. The low temperature approach also predicts step-like TMR and quantized in-plane spin transfer torque (STT) effects. The robust asymmetric STT respond is found due to voltage sign inversion in NP-MTJs with barrier asymmetry. Furthermore, it is shown how size distribution of NPs as well as quantization rules modify the spin-current filtering properties of the nanoparticles in ballistic regime. Different quantization rules for the transverse component of the wave vector are considered to overpass the dimensional threshold (d av ≈ 1.8 nm) between quantum well and bulk-assisted states of the middle layer.

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