Spintronics at nanoscale metal/ceramic interfaces

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Magnetic sensors using different effects based on the spin of electron are now being used in automobile and mobile systems as well as in DNA or protein detection [1, 2], under the name "spintronic devices (spintronics)". In parallel, the "Industry-4.0 revolution" – digitalization and intelligent systems – has further increased the potential of spintronic devices to be used in the "intelligent materials" category [3]. Design of the spintronic devices are based on Spin Hall (SHE) [4] and Tunnel Magneto Resistance effects (TMR) [5]. The disadvantages of spintronic devices using SHE and TMR effects can be listed as complex and costly production processes, the high energy consumption and necessity to use of an external magnetic field.

The recently developed spin Hall magnetoresistance (SMR) effect based on the SHE has drawn increasing interest. SHE effect is closely related to the spin-torque effect [6], which enables to design spintronic devices with low energy consumption and without an external magnetic field. In this context, different materials have been studied: YIG, $CoFe_2O_4$, $NiFe_2O_4$, Fe_3O_4, $LaCoO_3$, CeFeB, Pt, Pd [7, 8, 9]. Based on current research results, it is stated that the ratio of SMR effect at the extruded metal/ceramic interfaces such as W/CoFeB/MgO/Pt can be increased up to 70%, based on the comparison between nanoscale metal/ceramic binary and triple thin film systems [6]. Material systems with higher SMR effects can be more easily utilized in spintronic devices with lower production cost and low energy consumption [7, 8].

In the present work, the potential spintronic device structures and nanoscale metal/ceramic material systems are going to be discussed.

*This research is supported by the Scientific and Technological Research Council of Turkey (TUBITAK) and Anadolu University with different projects (Project numbers: 106M517, 1001F98, 1006F138).

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