Even Odd Oscillation in Tunnelling Magneto Resistance of Transition metal doped Metallo Porphyrin systems

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Abstract. Herein we report variation in Tunnelling magneto resistance (TMR) of TM- porphyrin against increase in d electrons from n=1 to 8; as the transition metal changes across the periodic table from Sc to Ni. We observed that highest value of TMR is observed for d^5 system the TMR becomes gigantic (10^{22}) at the equilibrium and on either side of it we need to apply certain amount of energy to reach appreciable TMR. An even-odd oscillation of TMR is observed against the number of electrons in d orbital. We also observed that with even number of d electrons TMR values is on lower side and in many cases below the accepted range (150%) of an efficient TMR device. In fact, to achieve an acceptable range we need to apply relatively larger energy (as large as 0.7 eV for Ni) probably due to preference of low spin statesin presence of even number of electrons in an atom. Observed feature has been explained usingmolecular orbital obtained in each case.

1. Introduction

Change in electrical resistance of a device against the variation of magnetic field/magnetic state is popularly known as magnetoresistance and when such a resistance is controlled through tunnelling barrier tunnelling magneto resistance (TMR) is developed. After the experimental validation of TMR at room temperature (close to 18%)in 1995 [1] spin dependent tunnelling magnetic materials (SDT) has become the centre of attention of many researchers working in the domain of spintronics. Over magnetoresistive materials, there are various advantages of SDT materials such as high field sensitivity, extensively high resistance, operating at low-field/low-power [2-5]. These SDT materials cause TMR with high magnitude due to coherent spin-dependent tunneling which is instigated from highly spin-polarized Δ_1 states [6]. It is reported that key factors for an effective TMR device like magnetoresistive random-access-memory (MRAM) are high TMR value along with low power consumption, greater signal level. Hence, investigations of novel TMR devices with high TMR values is a promising area of device applications. In the present study, we focus on a TMR device at the nanoscale and how correct choice of transition metal can influence the performance of such device.