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Magnetic Interactions in Pulsed-DC Sputtered Specular Bottom Spin Valve with Cu-Oxide spacers

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Abstract - The Spin Valve having metal spacer (Cu) layer are showing Giant Magnetic Resistance (GMR) effect. Recent years, it has been reported that IrMn top Spin Valve (SV) as a function of Cu spacer thickness posses a pinning and ferromagnet/antiferromagnet transition [1]. In the present study, for the first time the IrMn based bottom specular spin valves has been produced using Pulsed-DC magnetron sputtering and the correlation between interface structure, especially Cu-Oxide spacer interface and Cu-Oxide thickness dependent magnetic interaction discussed.

The Spin Valve having metal spacer (Cu) layer are showing Giant Magnetic Resistance (GMR) effect. Recent years, it has been reported that IrMn top Spin Valve (SV) as a function of Cu spacer thickness posses a pinning and ferromagnet/antiferromagnet (FM-AFM) transition [1]. This transition and temperature dependence [2] have a critical role on the determination of sensor dimension in sensor production and application area. These types of sensors are using as a magnetic read head in 100Gb/in^2 technologies [3]. To realize high sensitivity and use in the 100Gb/in^2 technologies, the enhancement of GMR effect has been intensively investigated. The nano-oxide layer (NOL) in a specular spin valve (SPSV), the electron does not reflect from the NOL and conserve its mean free path of majority spin direction, is fairly effective to increase GMR effect and decrease signal/noise ratio [4]. Nano-oxides layers (NOLs) formed by the partial oxidation of CoFe pinned and free layers [5] results in increase of GMR effect. According to author's best knowledge this transition has been not investigated in bottom SV systems until now.

For the first time in this study, IrMn based bottom specular spin valves Si/SiO_2/Ta(8 nm)/NiFe(8nm)/IrMn(10nm)/CoFe(2nm)/CuOx(x-Ar/O_2%)/CoFe(2nm)/Ta(5nm) were produced using Pulsed-DC magnetron sputtering methods (Pulsed-DC-MS) with Cu-Oxide spacer at different Ar/O_2% ratios (CuOx , x=10-40 Ar/O_2%). The structural properties and electrical properties of these SPSV have been compared. Their structure determined by means of an X-Ray Diffraction, Rocking curve and X-Ray Reflection method, and correlated with its electrical properties measured by Four Point Probe technique and magnetic behavior measured using vibration sample magnetometer. A decrease of Cu-Ox spacer thickness with increasing Ar/O_2 ratio ranging 0.2nm–1nm was found, however, no FM-AFM transition were observed. The free Layer exchange remains antiferromagnetic. Possible thickness dependent magnetic transitions for Ar/O_2 ratio below and over %20 is going to be investigated. Structural-electrical property correlations were compared for SPSV systems deposited using both techniques DC-MS and Pulsed-DC-MS Deposition.

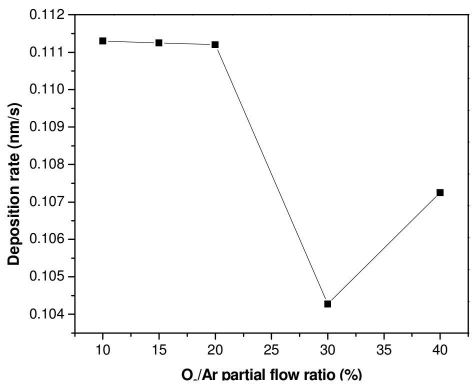

Figure 1: Ar/O_2 ratio dependence of deposition rate.

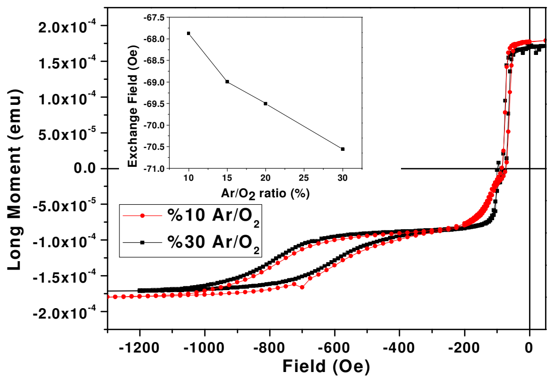

Figure 2: Dependence of Magnetic Hysterese and free alyer exchange on Ar/O_2 ratio

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