Room temperature magnetoresistance effect in organic spin valves

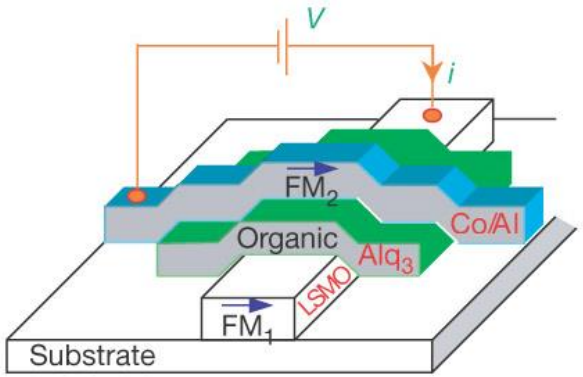
Yuewei Yin

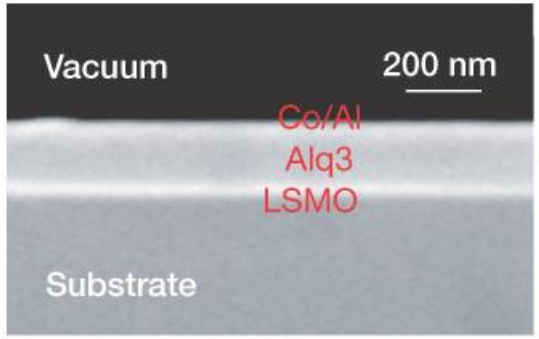
12/09/2016

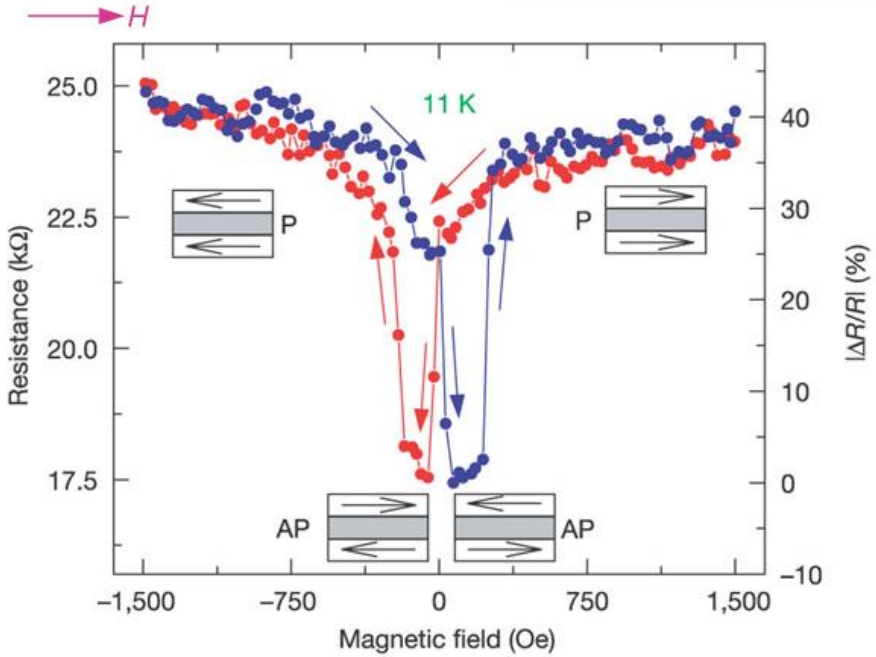
Prof. Xu's group meeting

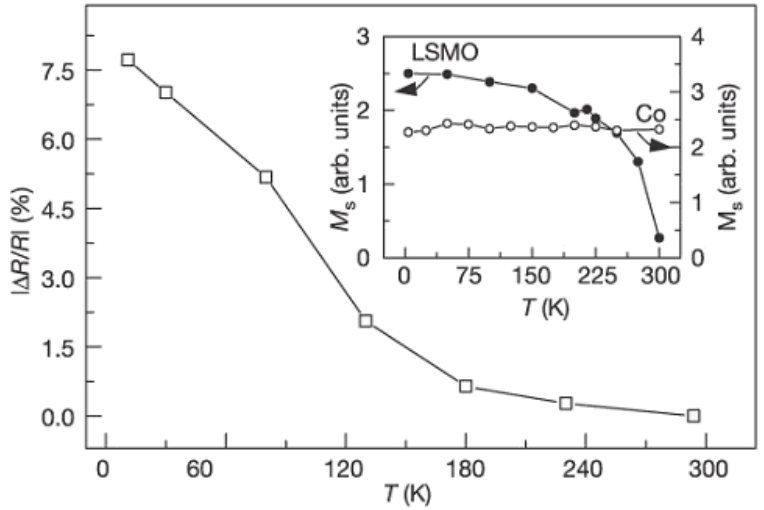
One of the important goals of studying OSVs extensively is to obtain large MR at room temperature.

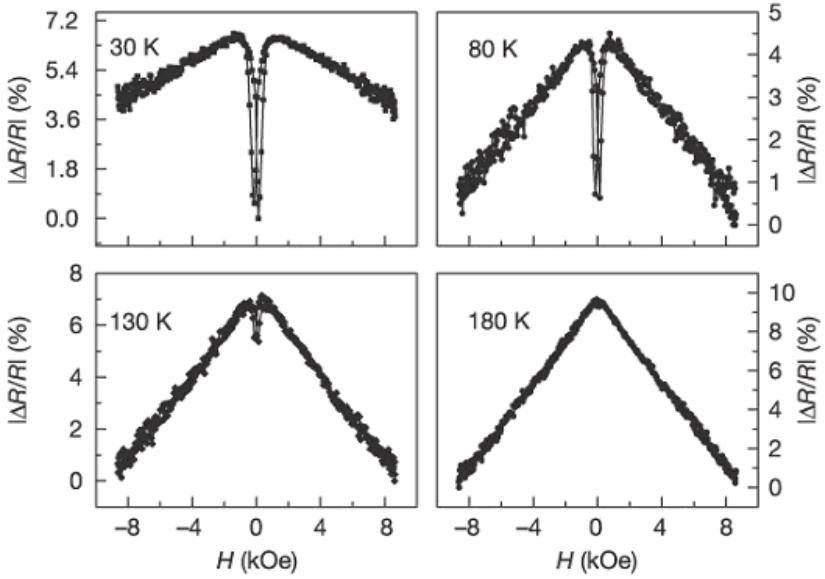
Decreasing MR with increasing temperature







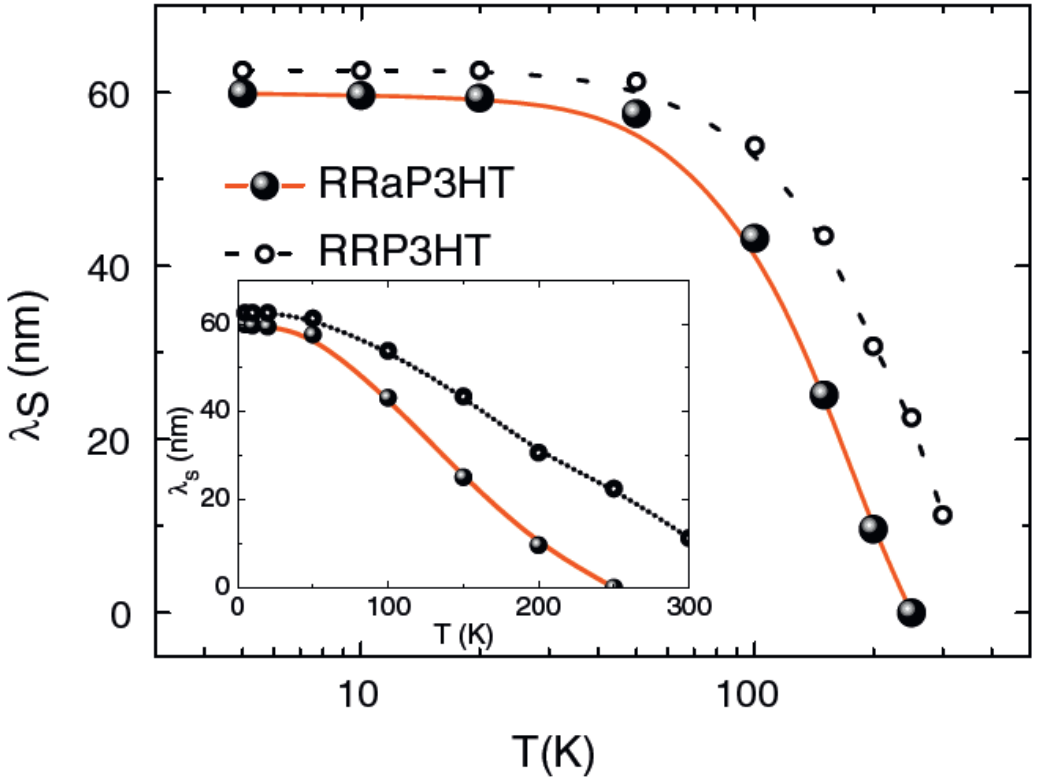




MR decreased steeply with increasing T and vanished at room temperature. The authors originally attributed the MR reduction to the **reduction of spin diffusion length** since the temperature dependence of magnetization of LSMO measured by MOKE is much weaker than that of the MR while the magnetization of Co is almost constant.

Nature 2004, **427**, 821

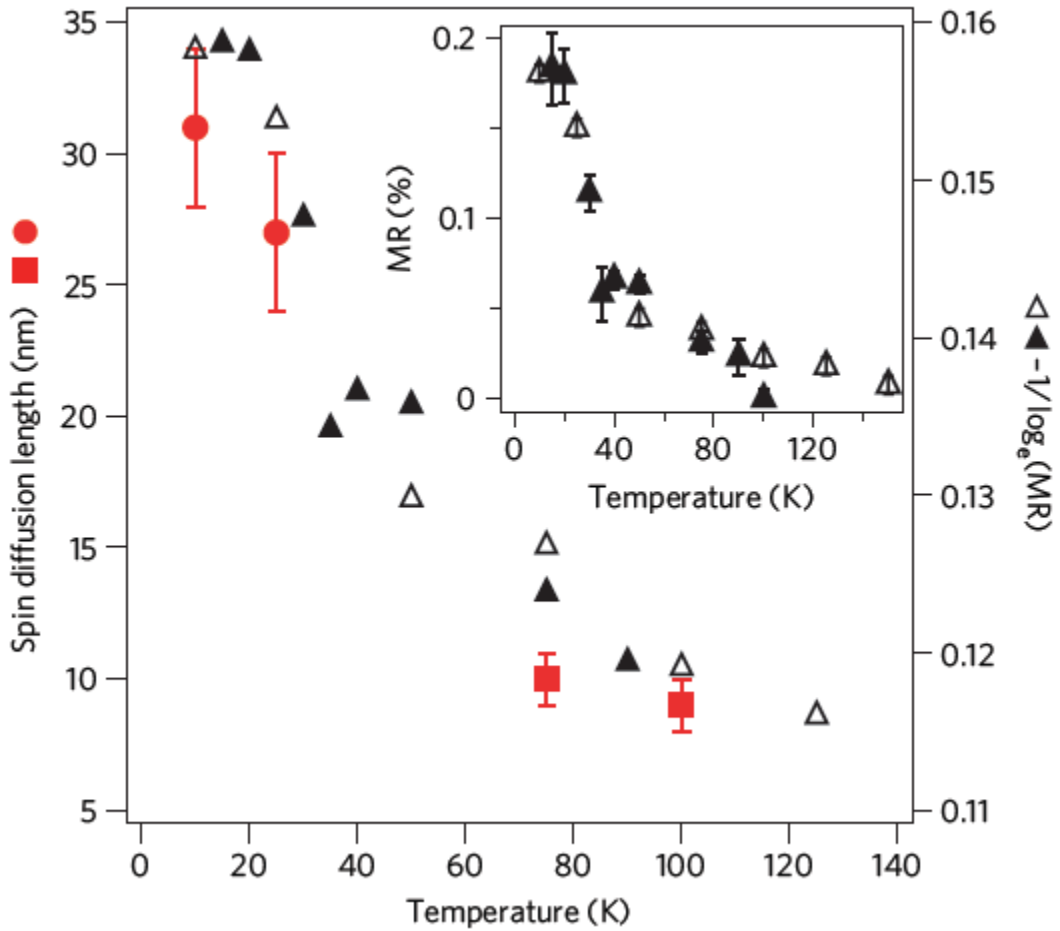
Spin diffusion length



$$\frac{\Delta R}{R} = \frac{R_{AP} - R_P}{R_{AP}} = \frac{2p_1p_2e^{-(d-d_0)/\lambda_s}}{1 + p_1p_2e^{-(d-d_0)/\lambda_s}}$$

The spin diffusion length of the OSCs decreases with increasing *T* .

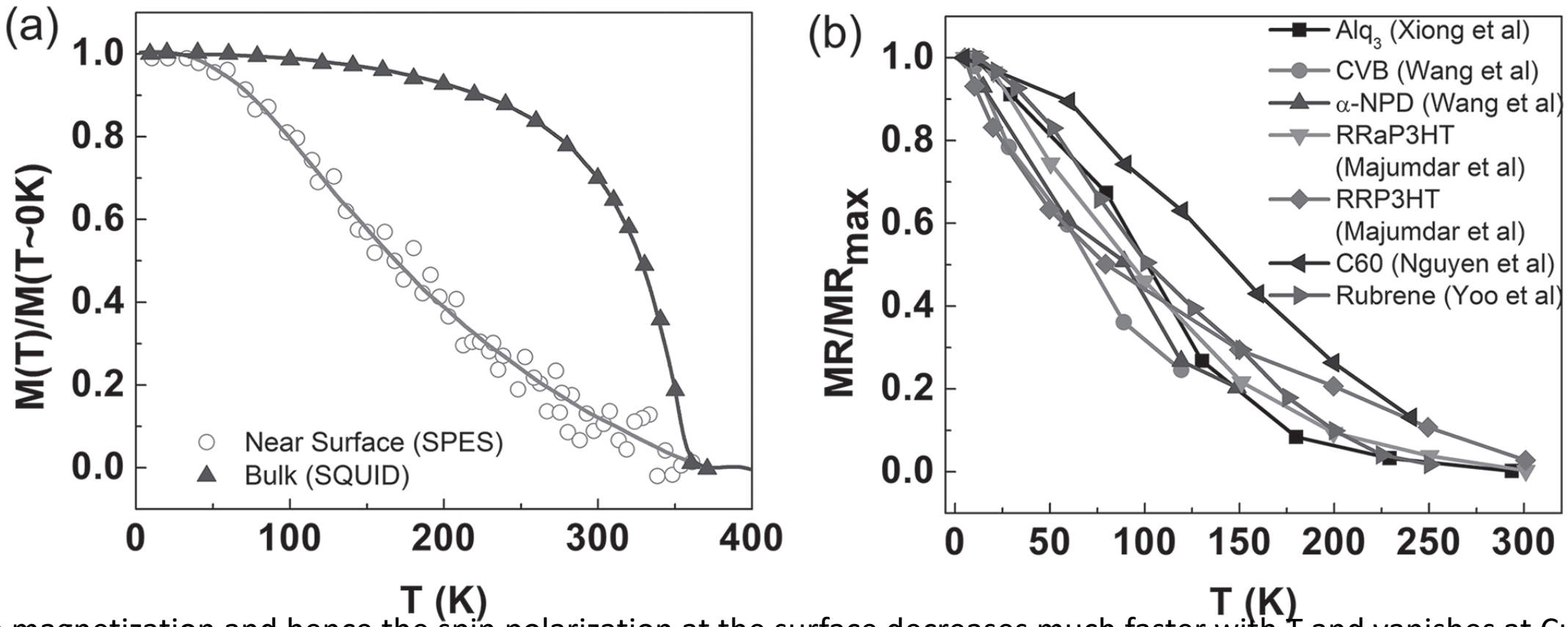
Synth. Met. 2013, **173**, 26



A direct measurement of spin diffusion length of Alq_3 using LE-μSR and its correlation with temperature dependent MR

*Nat. Mater.*2009, **8**, 109

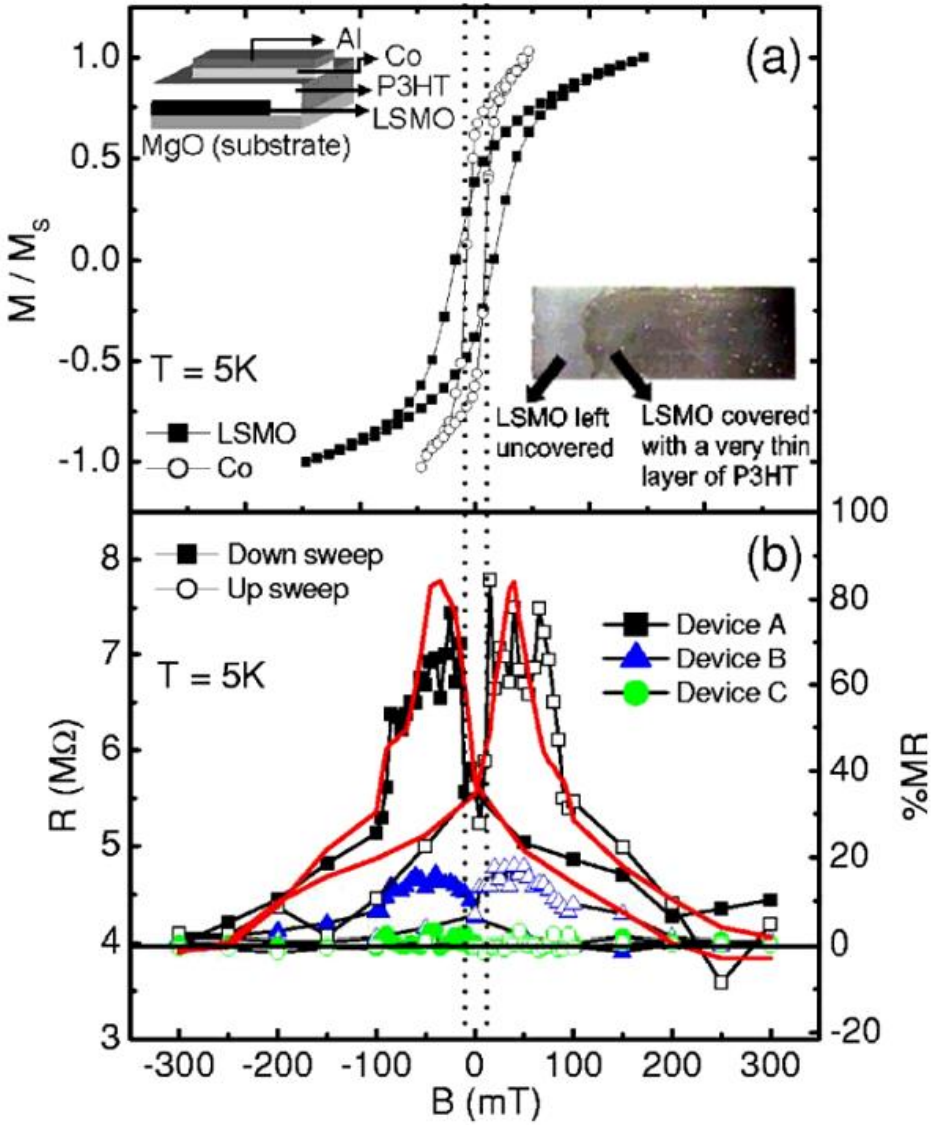
interface spin polarization

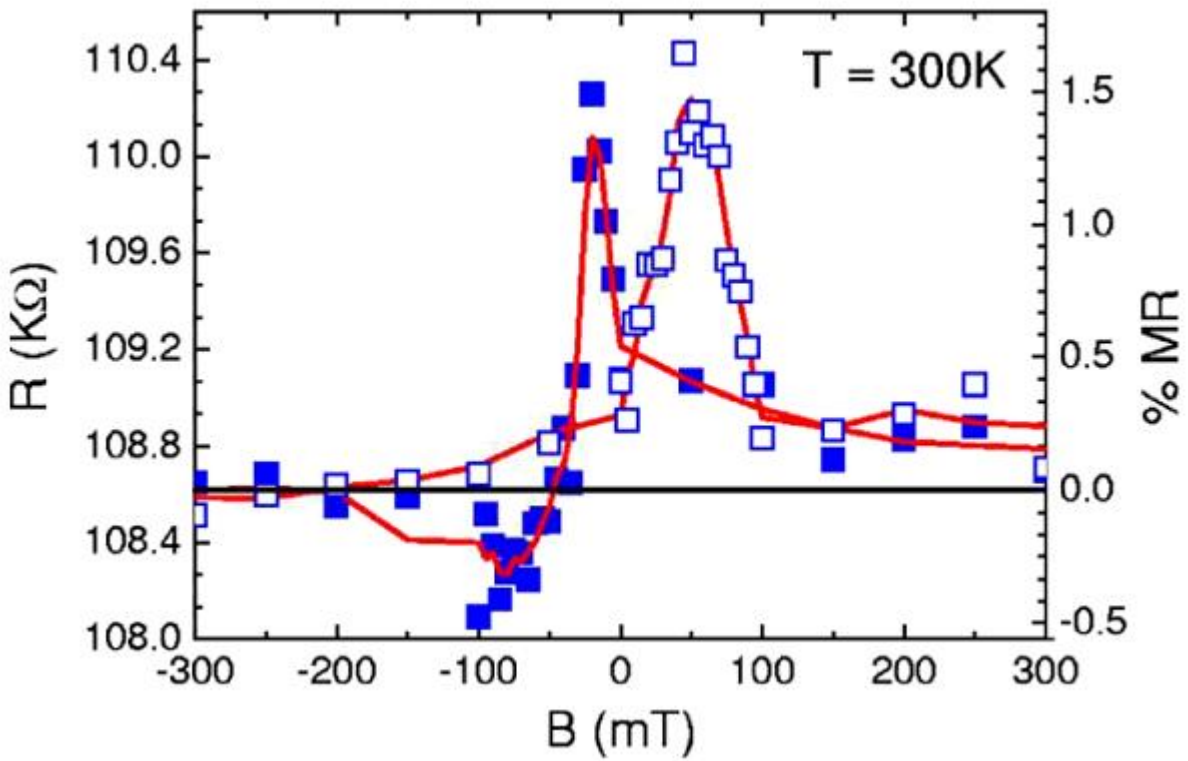


The magnetization and hence the spin polarization at the surface decreases much faster with T and vanishes at Curie temperature *T,* and in relation to this study, the temperature dependence of MR measured by many groups were shown to mainly correspond to the temperature dependence of the surface polarization.

Adv Mater 2016, **26**, 3881

First Room temperature MR effect

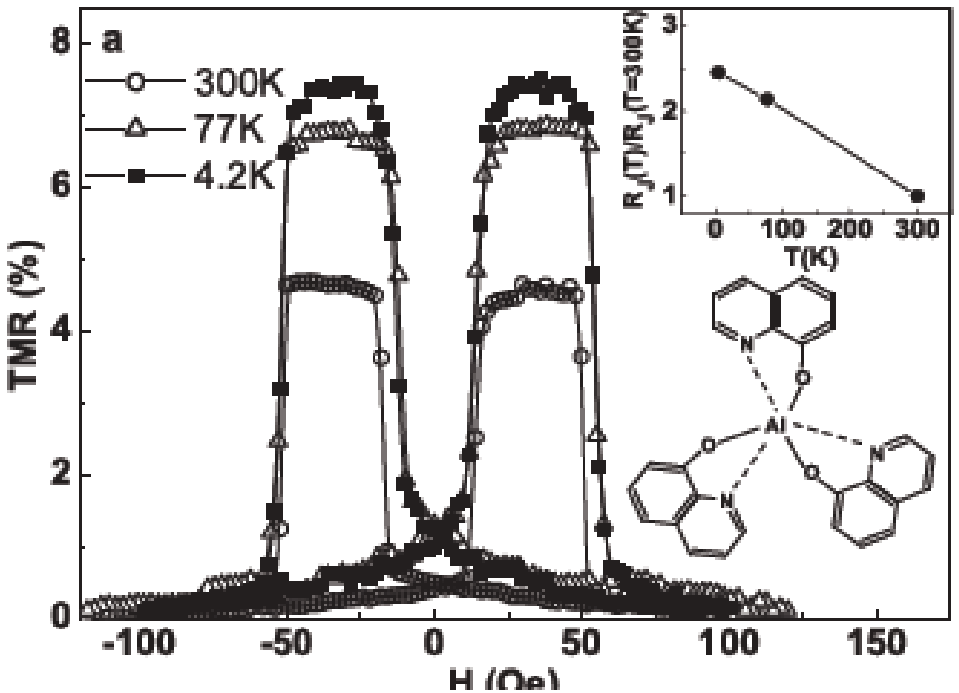


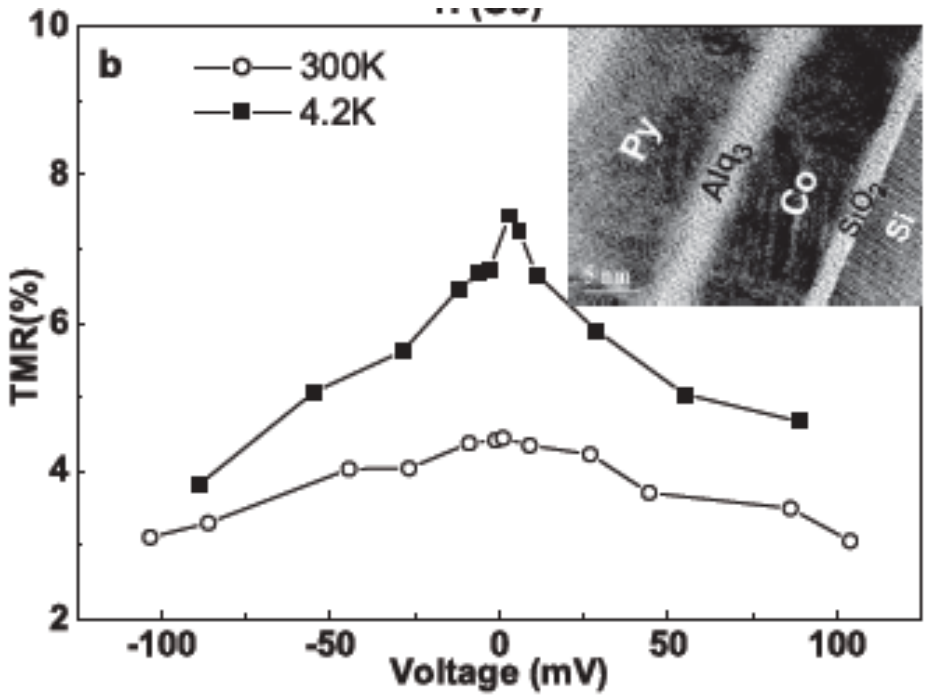


The first room temperature MR of about 1.5% on the LSMO/region-regular (poly3-hexylthiophene) (RRP3HT)(100 nm)/Co OSVs with 100 nm was observed by **annealing the organic film before the top electrode evaporation**.

Appl Phys Lett 2006, 89, 122114

Interfacial Al2O3 improved MR

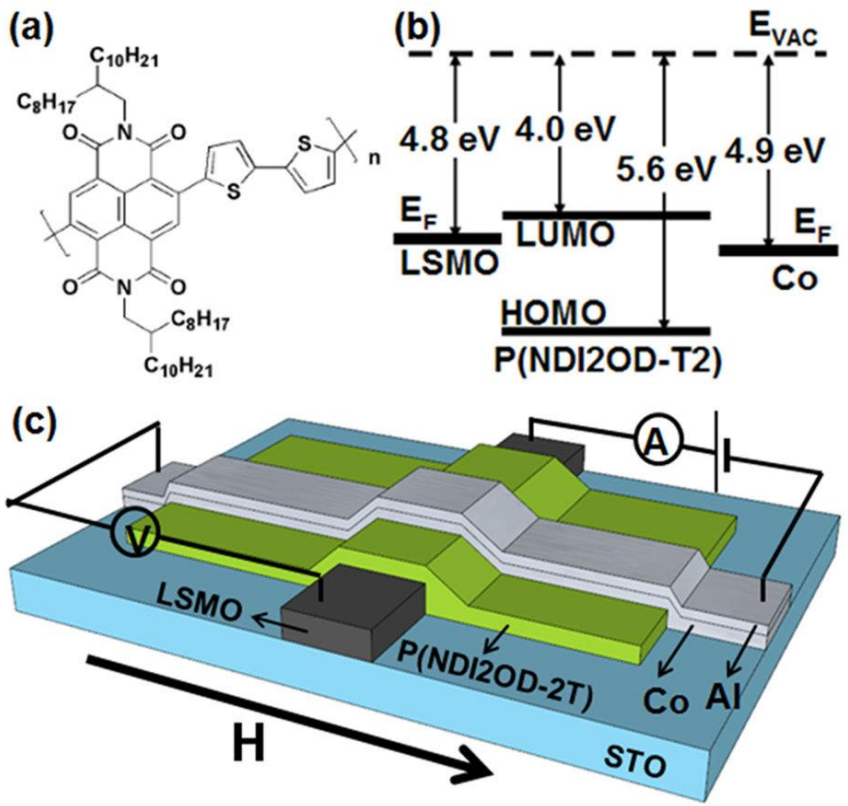




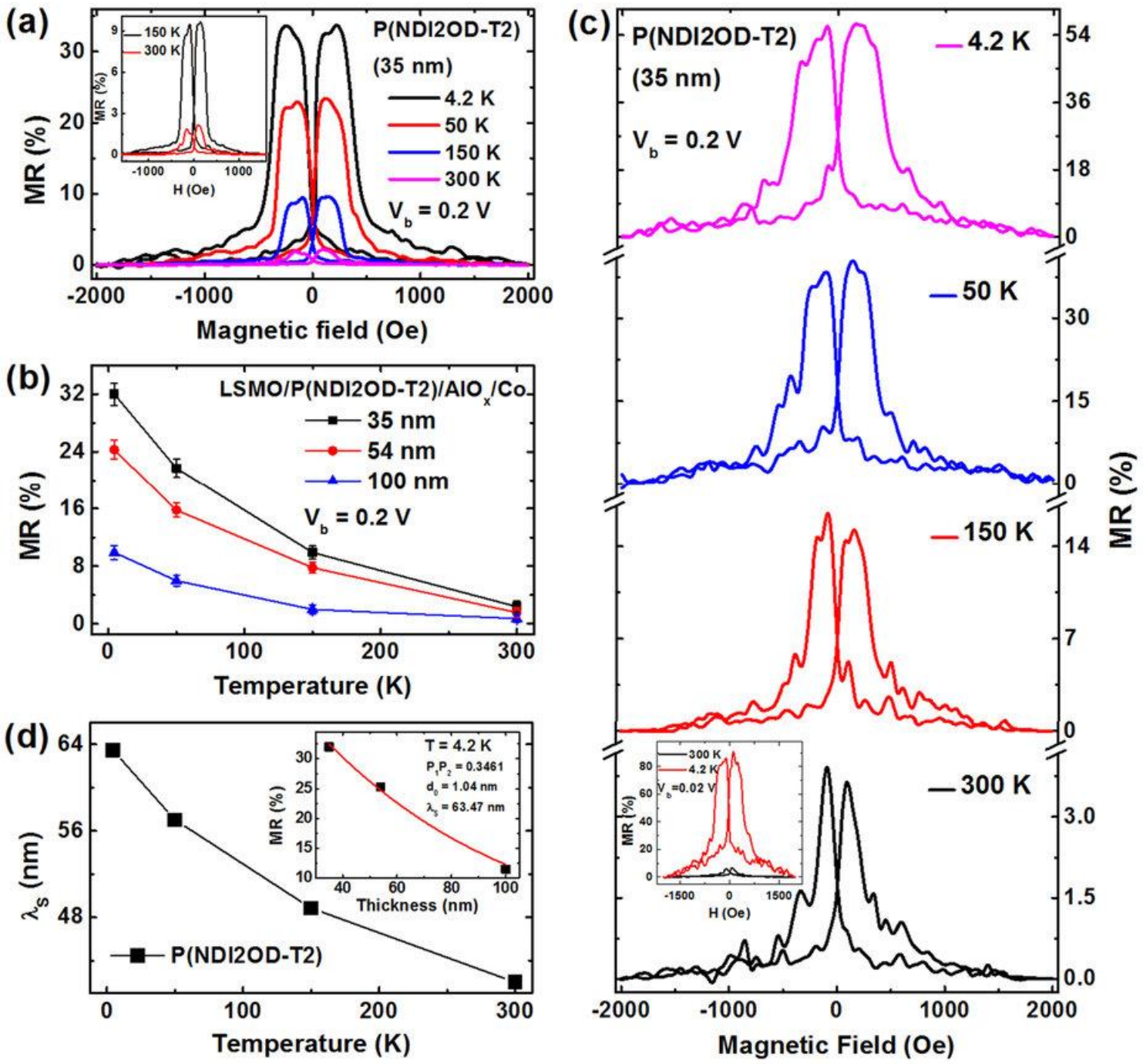
A TMR ~5% at room temperature was obtained in Co/Al_2O_3/Alq_3(<2 nm)/NiFe magnetic tunnel junction. The inclusion of Al_2O_3 in between Co and Alq_3 layer did play the role in energy level alignment of the ferromagnetic electrode/interface.

Phys. Rev. Lett. 2007, **98**, 016601

Interfacial Al2O3

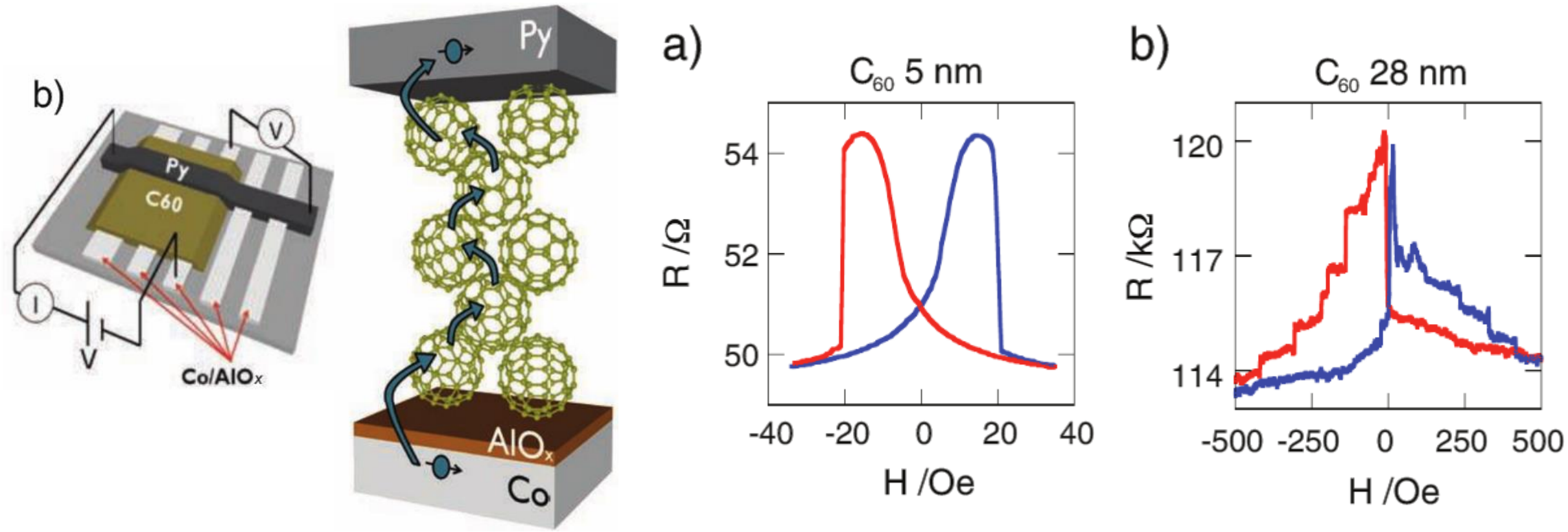


weak temperature dependent spin diffusion length



Sci. Rep. 2015, **5**, 9355

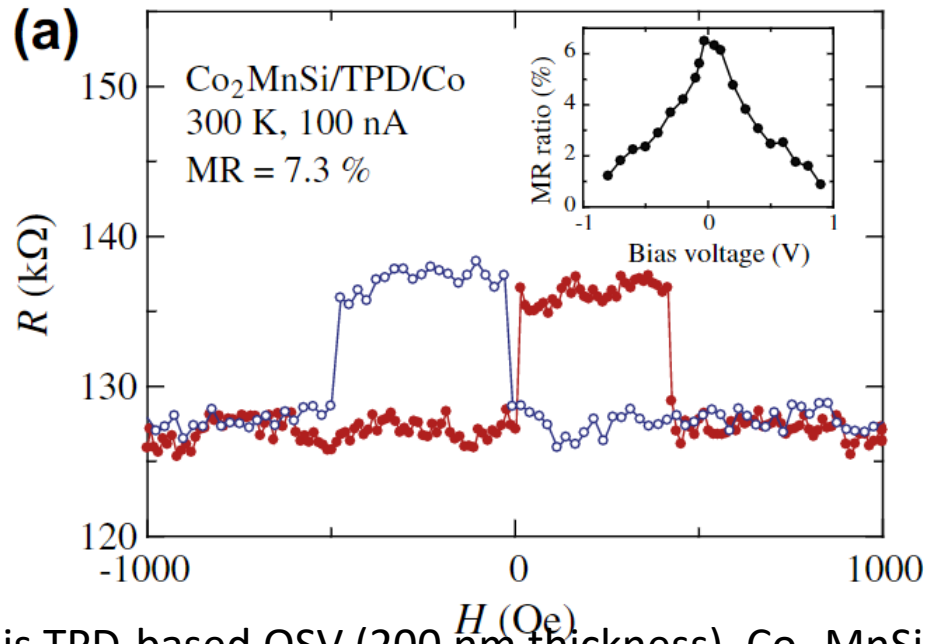
RT MR in C60 based OSVs

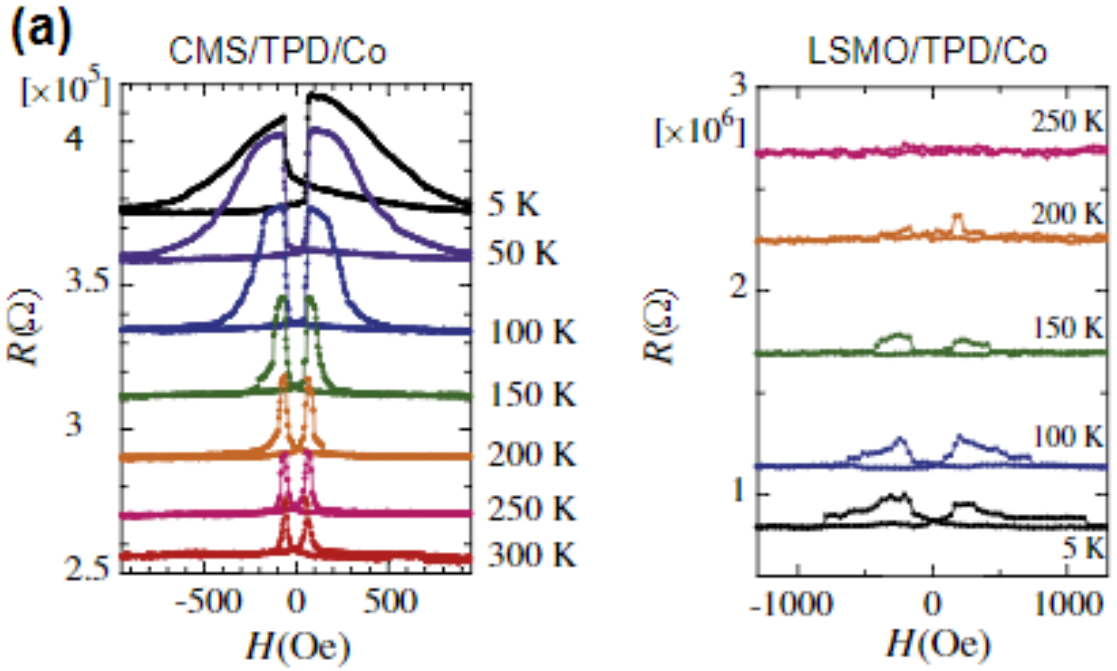


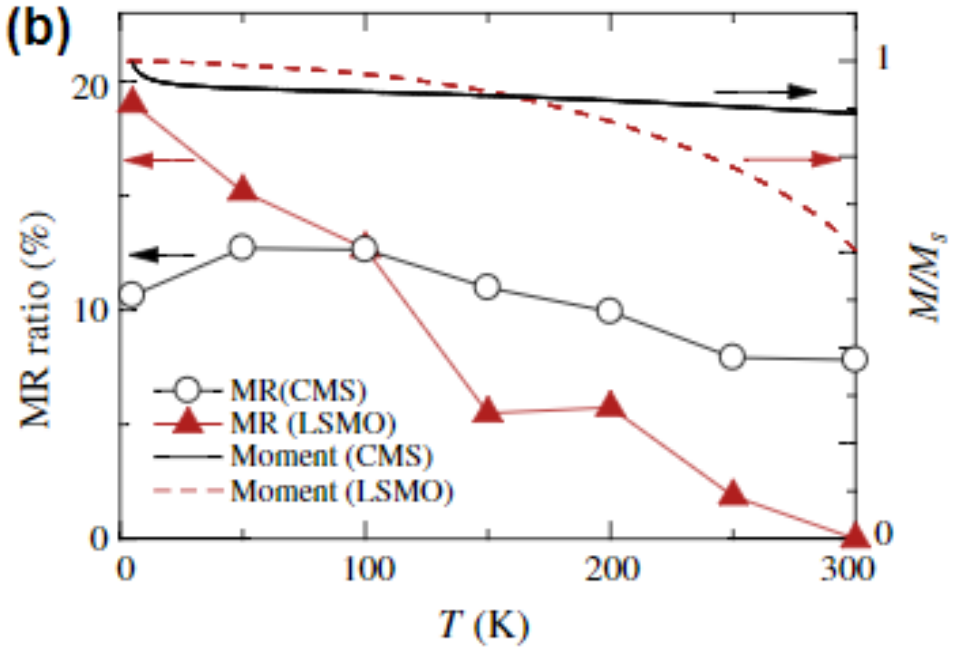
Significant room temperature MR values (in excess of 5%) on C_{60}-based vertical spin valves with different thickness of the C_{60} interlayer (from 5 nm to 28 nm) up to high applied biases (~1 V).

Adv. Mater. 2011, **23**, 1609

Heusler alloy based OSVs







In this TPD-based OSV (200 nm thickness), Co_2MnSi Heusler alloy with large Curie temperature ensures a large spin injection at room temperature and nearly 10% MR in it.

Org. Electron. 2013, **14**, 3186