Abstract Submitted
for the MAR12 Meeting of
The American Physical Society

Temperature and temporal evolution of nonlocal spin signals[1] HAN ZOU, YI JI, University of Delaware — An unusual non-monotonic temperature dependence of spin signals was previously observed for nanoscale metallic nonlocal spin valves (NLSV): The spin signal increases as the temperature decreases from room temperature, reaches a maximum value around 50 K, and then decreases as the temperature approaches 4 K. This has been interpreted as due to a high rate of surface spin-flip scattering in the nonmagnetic channel, but the origins of the high surface spin-flip rate are yet to be understood. In this work, we show that for an as fabricated Py-Cu NLSV device this temperature dependence is clearly observed. The device was then stored in the ambient environment for a period of 5 months. Afterwards, an increase of the spin signals was found, and more interestingly the temperature dependence became monotonic. From room temperature to 50 K the spin signal increases, but from 50 K to 4 K the spin signal levels off instead of decreasing further. We conclude that the surface spin-flip scattering originates from the magnetic impurities embedded in the Cu channel near the side surfaces. The impurities are introduced into the Cu during the fabrication procedure. Upon oxidizing the Cu in the ambient environment, the surface impurities are buried in copper oxide and become less accessible to the conduction electrons. Therefore the surface spin-flip rate is reduced over time, resulting in a larger spin signal and monotonic temperature dependence.

[1]This work is supported by DOE Grant No. DE-FG02-07ER46374. Han Zou
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Date submitted: 16 Nov 2011 Electronic form version 1.4