Evolution of low-frequency resistance noise during annealing in CoFeB/MgO/CoFeB tunnel junctions

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— We have studied the evolution of tunneling magnetoresistance (TMR) and resistance noise in magnetic tunnel junctions (MTJs) as a function of annealing time at 425°C. Previously, we showed that short annealing times do lead to significant improvement in the MgO crystal structure and crystallization of the CoFeB electrodes, resulting in large TMR values up to 200%. We also observe that the low-frequency resistance noise decreases significantly after annealing for only a few minutes. The resistance noise has a 1/f spectrum and is quantified by a Hooge-like parameter, $\alpha$, given in units of $\mu m^2$. In unannealed samples $\alpha$ is of order $10^{-9}$ $\mu m^2$ and decreases with increasing voltage bias. Upon annealing, $\alpha$ drops to $10^{-10}$ $\mu m^2$ and is less dependent on bias, particularly in the parallel configuration. We attribute the decrease in $\alpha$ and its bias dependence, $\alpha(V)$, to a reduction of defects in and around the barrier due to annealing. The implications for optimizing the signal to noise ratio of MgO-based MTJ sensors will also be discussed.

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