Resistive Switching in Ferroelectric BiFeO$_3$ Nano-Island Based Switchable Diodes

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Ferroelectric-resistive memories based on ferroelectric diode and tunnel junctions have demonstrated that it is possible to achieve high resistive ON/OFF ratio, high speed and low write power with a high reproducibility by controlling ferroelectric polarization. Here, we explored the local charge conductions and their coupling with ferroelectric polarization in highly oriented ferroelectric BiFeO$_3$ (BFO) nano-islands array by using conductive atomic force microscopy (CAFM) and piezoresponse force microscopy (PFM). We observed a switchable diode effect in BFO nano-islands grown on SrRuO$_3$/SrTiO$_3$ (SRO/STO) substrate, which showed the direct correlation between rectification and ferroelectric polarization directions. The rectification ratios reached a maximum of ~500 at 0.6 V. BFO nano-islands also exhibited resistive change with ON/OFF ratios as high as ~753 at a low reading voltage of ~0.5 V. These results suggest that BFO nano-islands with well-controlled domain structures can be a potential candidate for ferroelectric-resistive memory elements with high resistive ON/OFF ratio, low power consumption and large capacity.