Electrical switching behaviors in Two-demensional flake of $BaTiS_3$

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Abstract:

The exploration of novel electronic materials is very important. Our study focuses on the electrical switching behavior in $BaTiS_3$. Based on calculations, ferroelectricity is predicted to exist in $BaTiS_3$ at room temperature. This ferroelectric behavior originates from the polar displacement of Ti atoms. In this work, we firstly observed the ferroelectric-like electrical switching behavior in Two-demensional $BaTiS_3$. And we found two distinct phenomena—memristor-like and ferroelectric-like electrical switching—within the same material, presenting a unique and unprecedented phenomenon. Our work encompasses a comprehensive characterization of these phenomena, study their individual properties, interactions and mechanisms. The presented results pave the way for innovative applications and further exploration of the potential of $BaTiS_3$ in emerging electronic technologies.

In this study, we exfoliated the $BaTiS_3$ flakes from bulk $BaTiS_3$. As shown in Fig.1, there are two different kinds of Two-dimensional $BaTiS_3$: ac-plane flakes, demonstrating anisotropic properties, and ab-plane flakes, displaying isotropy. The hysteresis loop during the double sweep of electric field for phase and amplitude in Fig.2 is the evidence of the piezoelectric. This observation confirms the piezoelectric effect alone the a-axis. In Fig.3, we further measure the I-V curves and C-V curves for ab-plane devices, and also found the corresponding switching behavior.

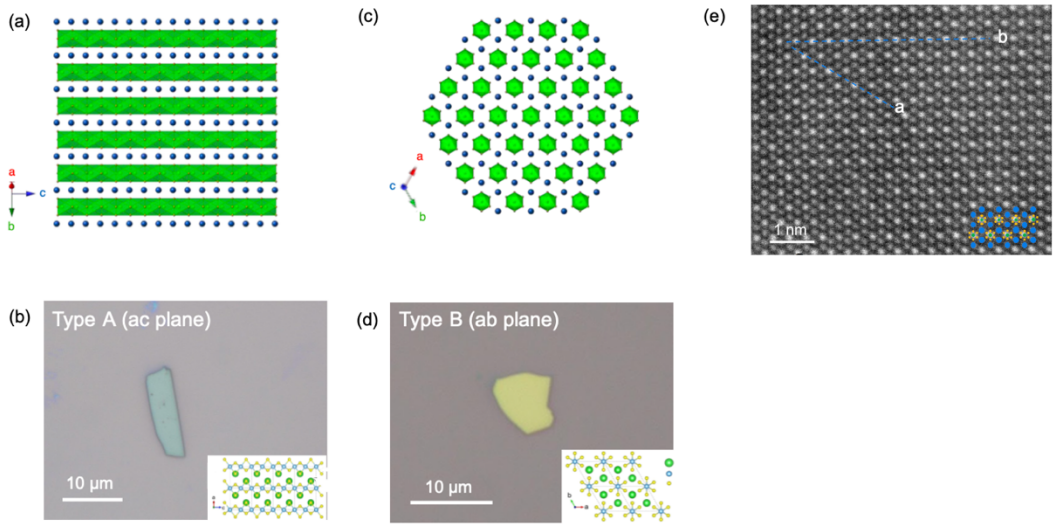

Fig. 1. BTS flakes with different morphologies and orientations. (a)(c). Structure diagram for ac-plane BTS and ab-plane BTS[1]. (e). STEM images of ab-plane $BaTiS_3$

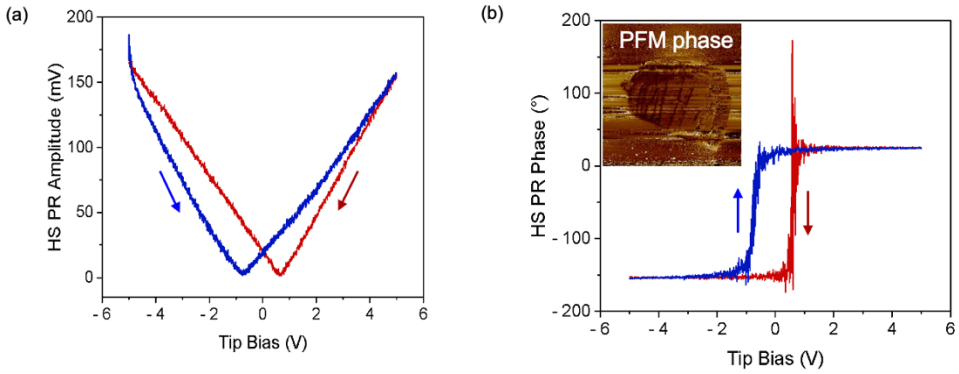

Fig. 2. Vertical PFM measurements for $BaTiS_3$ flake

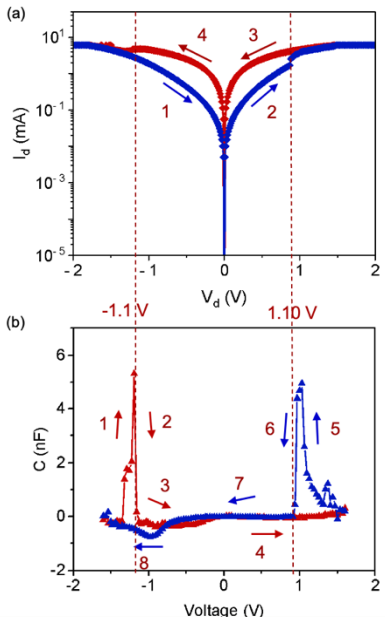

Fig. 3. Ferroelectric-like electrical switching. (a). I-V measurement. (b). C-V measurement

[1]. Zhao B, Hoque MS, Jung GY, Mei H, Singh S, Ren G, Milich M, Zhao Q, Wang N, Chen H, Niu S. Orientation-controlled anisotropy in single crystals of quasi-1D BaTiS3. Chemistry of Materials. 2022 Jun 10;34(12):5680-9.