Establishment of Novel Non-Volatile Memory Device with Single-Molecule Electret

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Recently, with expansion of big data applications and "Internet of things (IoT)" technology, the demand for high-density memory have been desired. Ferroelectric-based memory has much attention because of its unique memory properties such as low power consumption, fast switching speed and long retention time. However, these materials have intrinsic miniaturization limitations below 100 nm, thus it is difficult to fabricate high-density memory. From this point, our group finally overcame the size effect by using single molecule of Preyssler-type polyoxometalates (POM), $[Tb^{3+}\subset P_5W_{30}O_{110}]^{12-}$.[1)] This molecule has cage-like W-O frameworks and one metal ion is encapsulated in either two stable ion sites inside the molecule. By applying external electric field to this molecule, the ion movement between two ion sites were induced and ferroelectric-like polarization hysteresis appeared within a single-molecule manner. This was named single-molecule electret (SME). Thus, the SME are expected to be used for ultra-high-density memory with good memory properties like FeRAM and FeFET. In this work, we fabricated field-effect transistor (FET) with embedded POM and evaluate their memory properties.

We fabricated lateral-type FET to evaluate the memory properties of POM. POM films were coated on the substrate by cast procedure and it filled the gaps between gate electrode and channel moiety. Measurement of V_{GS}-I_{DS} characterization showed FET behavior with wide memory window (Fig. 1). This result clearly indicated that POM work as gate insulator and memory materials.

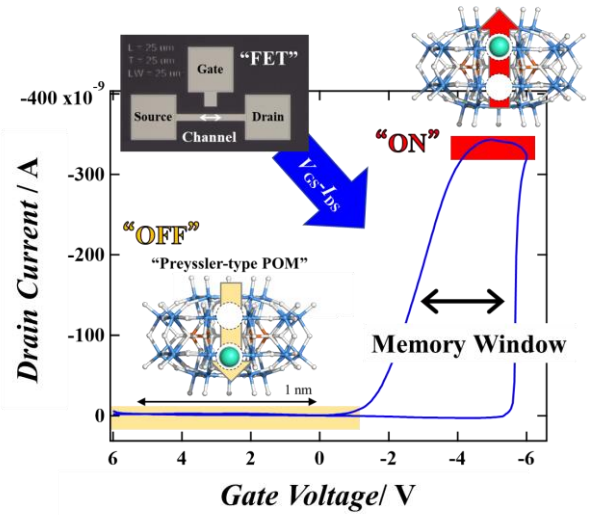

Fig.1. Molecule structure and memory properties of Preyssler-type polyoxometalates.

1) C. Kato, S. Nishihara, *et al*., *Angew. Chem. Int. Ed.*, **2018**, *57*, 13429-13432.