Center for Artificial Low D Electronic Systems

2023 IBS-CALDES Seminar

- ✓ **Date & Time: May 8 (Mon), 2023, 4:00PM**

- ✓ **Venue : Seminar Room 302, Science Building #3**

- ✓ **Speaker & Title**

  Prof. Hyobin Yoo (Sogang Univ.)

  Operando **electron microscopy investigation of polar domain dynamics in twisted van der Waals homobilayers**

Organized by Dr. Jhin Hwan Lee (jhinhwan@ibs.re.kr, 054-279-9894)

▪ 04:00PM~

Operando electron microscopy investigation of polar domain dynamics in twisted van der Waals homobilayers

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Conventional antiferroelectric (AFE) materials with atomic scale anti-aligned electric dipoles exhibit a linear dielectric response to the small electric fields. Under a strong electric field, the AFEs undergo a transition to a ferroelectric (FE) phase where the dielectric response becomes hysteretic. Moiré superlattice formed in the twisted stacks of noncentrosymmetric van der Waals (vdW) crystals exhibits an array of triangular domains with anti-aligned electric dipoles that alternate in moiré length scale. In this moiré domain-antiferroelectic (MDAF) arrangement, the distribution of electric dipoles is clearly distinguished from that of recently reported 2-dimensional ferroelectrics (FEs), suggesting dissimilar domain dynamics in MDAF and FE states. Here we performed operando transmission electron microscopy (TEM) investigation on twisted bilayer transition metal dichalcogenides that enables real-time observation of the polar domain response to applied electric fields. We find that the topological protection provided by the domain wall network (DWN) in the MDAFs, results in linear dielectric response to the small electric field but prevents the MDAF to FE transition even at large electric field. As one decreases the twist angle, however, MDAF to FE transition occurs when the hysteretic domain wall motion becomes permissible due to the disappearance of the topologically protected DWN. In this FE phase, we find the domain dynamics in response to vertical electric fields is governed by the consecutive domain wall pinning-depinning process. Aberration corrected scanning TEM (STEM) analysis identifies the microstructural origin for the domain wall pinning, providing structural insight on how to improve the switching speed of vdW FE.