Direct observation of domains and boundaries of large-area 2D materials by optical birefringency

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As properties of 3D crystals including metal, organic and inorganic semiconductors are governed by their shape of crystal domains and defect structures, controlling the domain is one of the most important issues to prepare the high-quality 2D materials. Thus, a number of works have been conducted over the last decade to control the domain structure of graphene and recently 2D transition metal dichalcogenides. However, obtained properties of 2D materials are much less than ideal properties because the opto-electronic, chemical and mechanical properties are strongly influenced by the sizes and boundaries of their domains. Previous tools developed to probe domains, including TEM, STM have been limited to small-area measurements of up to several micrometer size, and they require complex sample preparation procedures with a lot of time. Here, we developed a very simple and rapid method to observe and determine the boundaries of 2D materials. The technique, which depends on observations of nematic liquid crystal textures on the surface of 2D materials, does not damage the sample and is not limited by domain size.