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Ripple domains on graphene on a SiO_2 substrate SUNGJONG WOO, Korea Inst for Advanced Study, Seoul, Korea, JIN SIK CHOI, Konkuk University, Seoul, Korea, YOUNG JUN CHANG, University of Seoul, Seoul, Korea, YOUNG-WOO SON, Korea Inst for Advanced Study, Seoul, Korea, YEONGGU PARK, MI JUNG LEE, IK-SU BYUN, JIN-SOO KIM, Konkuk University, Seoul, Korea, CHOON-GI CHOI, Electronics and Telecommunications Research Institute, Daejeon, Korea, AARON BOSTWICK, ELI ROTENBERG, Lawrence Berkeley National Laboratory, Berkeley, California, BAE HO PARK, Konkuk University, Seoul, Korea — Out-of-plane lattice distortions in two-dimensional materials are prevalent among structural movements at finite temperature. Graphene's negative thermal expansion coefficient is a direct consequence of such an intrinsic property. In our recent work, we have shown that friction measurements on graphene exfoliated on a silicon oxide substrate exhibit an anomalous anisotropy whose origin is attributed to the formation of ripple domains. We further uncover the atomistic origin of the observed friction domains using a newly developed method called cantilever torsion microscopy (CTM) together with angle-resolved photoemission spectroscopy (ARPES) measurements. We experimentally demonstrate that ripples on graphene are formed along the zigzag direction of the hexagonal lattice. We have also calculated theoretically the bending stiffness of carbon-carbon bonds and adhesive interactions between graphene and the surface underneath it that are consistent with our experimental results.

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