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Observation of Piezoelectricity in Free-standing Monolayer Molybdenum Disulfide HANYU ZHU, YUAN WANG, JUN XIAO, MING LIU, SHAOMIN XIONG, ZI JING WONG, ZILIANG YE, YU YE, XIAOBO YIN, XIANG ZHANG, Univ of California - Berkeley — Piezoelectricity offers precise and robust conversion between electricity and mechanical force, which originates from the broken inversion symmetry of atomic structure. Yet reducing the size of bulk piezoelectric materials to single molecular layer was challenging, since the surface energy can cause piezoelectric structures to be thermodynamically unstable. Here we report experimental evidence of piezoelectricity in free-standing single layer of molybdenum disulfide (MoS_2) crystal, with measured piezoelectric coefficient e_{11} =2.9*10^{-10} C/m. The free-standing measurement of the intrinsic piezoelectricity is free from the substrate effects, such as doping and parasitic charge. We observed oscillation of piezoelectric response in MoS_2 in odd and even number of layers due to breaking and recovery of inversion symmetry, respectively, in sharp contrast to bulk piezoelectric materials. Through the angular dependence of electro-mechanical coupling, we uniquely determined the 2D crystal orientation. The piezoelectricity discovered in single molecular membrane promises new applications in low-power logic switch and ultrasensitive sensors scaled down to single atomic unit cell – the ultimate material limit.

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