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Phase Transition Structural Superlubricity

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Structural superlubricity refers to a state with almost vanishing friction and wear between crystalline surfaces in incommensurate configurations. However, thus far, this phenomenon has been observed only at solid-solid interfaces. Here, we constructed an in-situ heterojunction between a crystalline graphene boundary tribofilm and a pressure-induced solid-phase 1–dodecanol molecular layer, achieving structural superlubricity in a liquid-solid interface for the first time. This novel state, termed phase transition structural superlubricity (PTSS), is induced by incommensurate slip at the in-situ heterojunction. Atomic force microscopy (AFM) experiments and molecular dynamics (MD) simulations demonstrated that the friction of solid-phase 1–dodecanol molecular layer exhibits a periodicity of 180°. Notably, the PTSS arises when the molecular axis of 1–dodecanol is oriented 90° to the direction of friction. These findings bridge the gap between liquid superlubricity and solid superlubricity, shedding substantial light upon achieving structural superlubricity across a broad range of environments.

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