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Bulk vs. Nanoscale WS_2: Finite Size Effects and Solid State Lubrication[1] S. BROWN, J.L. MUSFELDT, University of Tennessee, I. MIHUT, J.B. BETTS, A. MIGLIORI, Los Alamos National Laboratory, R. ROSENTSVEIG, R. TENNE, Weizmann Institute of Science — Metal dichalcogenide nano-structures have recently attracted attention due to their unique closed cage structures, hierarchy of length scales, and outstanding solid-state lubrication behavior. In order to understand the bulk vs. nanoscale effects, we measured the low temperature specific heat of layered and nano-particle WS_2. Below 9 K, the specific heat of the nano-particles deviates from that of the bulk counterpart. Further, it deviates from the usual T^3 dependence below 4 K, due to both finite size effects and inter-particle interactions. This separation of nanoscale effects from T^3 dependence can be modeled by assuming that the phonon density of states is flexible, changing with size and shape of the nanoparticle. We invoke relationships between low temperature T^3 phonon term, Young's modulus, and friction coefficient to assess the difference in the tribological properties. Based on this analysis, we conclude that the improved lubrication properties of the nanoparticles are extrinsic in origin.

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