Thermal Conductance between Water and nm-thick WS_2: Extremely Localized Probing Using Nanosecond Energy Transport State-Resolved Raman

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Liquid-solid interface energy transport has been a long-time research topic. Past research mostly focused on theoretical study while there are only a handful of experiment work because of the extreme challenges faced in measuring such interface. Here, by constructing a nanosecond energy transport state-resolved Raman spectroscopy (nET-Raman), we characterize the thermal conductance across liquid-solid interface: water-WS_2 nm film. In the studied system, one side of nm-thick WS_2 film is in contact with water and the other side is isolated. WS_2 samples are irradiated with 532 nm wavelength lasers and its temperature evolution is monitored by tracking the Raman shift variation of the E_{2g} mode at several laser powers. Steady and transient heating states are created using continuous wave and nanosecond pulsed lasers, respectively. We find that the thermal conductance between water and WS_2 is in the range of 2.5~11.8 $MW \cdot m^{-2} \cdot K^{-1}$ for three measured samples (22, 33, and 88 nm thick). This is in agreement with molecular dynamics simulation results and previous experimental works. The slight differences are attributed mostly to the solid-liquid interaction at the boundary and the surface energy of different solid materials. Our detailed analysis confirms that the nET-Raman is very robust in characterizing such interface thermal conductance. It completely eliminates the need of laser power absorption and Raman temperature coefficient, and is insensitive to the large uncertainties in 2D materials properties input.