Enhancement of Interface Thermal Conductance between Polystyrene Nano-Film and Sapphire

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Tuning interfacial thermal transport is significant for many technologies including nanoelectronics, solid-state lighting, energy generation and nanocomposites, therefore, a better understanding of the atomic-scale structural features contributing to interfacial heat transport between dissimilar materials is needed. Here, we demonstrated an experimental study on the correlation between interfacial thermal conductance and interfacial adhesions cross the interfaces of spin coated polystyrene (PS) and sapphire. Time-domain thermoreflectance method (TDTR) is applied to measure the thermal conductance of PS/sapphire interfaces, while their interfacial adhesions are characterized by scratch test experiments. And samples with different kinds of interfaces are manipulated for analyzing the correlation mentioned above. Two major ways are applied to enhance the heat transport across PS and sapphire, including varying rotation speed of the spin-coating process and introducing self-assembled monolayer (SAM) with different terminal groups to tailor polymer and substrate. The results show a great enhancement of the interfacial thermal conductance between PS and sapphire by both ways, which underscore the importance of interfacial bond strength as a bridge to describe and control interfacial thermal transport between polymer and other materials. This fundamental study on the heat transport across ultra-thin polymer and substrate interfaces can impact on the applications of thermal management and the reliability of macro- and micro-electronics, where polymeric and hybrid organic-inorganic thin films have been employed.