Adsorption-based Thermal Rectifier

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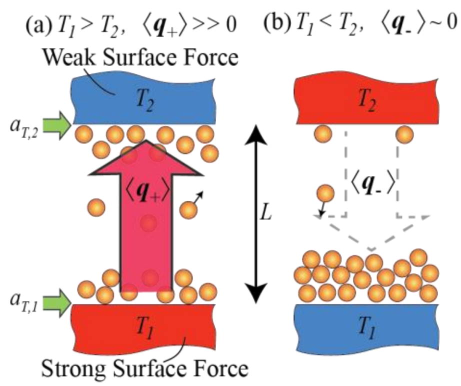
A functionality of controlling a thermal transport direction, i.e., thermal rectifier, is in a great need, to increase the thermal transport, conversion, and storage efficiencies. However, the efficiency of the existing thermal rectifiers has been poor for the practical applications. Here, a gas-filled nano-gap structure consisting of sides with two different surface coatings is employed to design an efficient thermal rectifier. A key mechanism is to utilize the nonlinear thermal transport in Knudsen regime by manipulating the thermal accommodation coefficients using the nanostructures. This study is to use the kinetic theory and molecular dynamics simulation to increase the thermal rectification in a nano-gap structure for a specified range of temperature and pressure. This can be achieved by changing the nano-gap length, the gas, or the surface materials and finding an optimum case where the thermal accommodation coefficient in one contact side of the nanogap is high, while the other side of the gap has the small amount of thermal accommodation coefficient.



Condensable-gas-filled nano-gap with two surface force coatings acting as a thermal rectifier. (a) $T_1 > T_2$ for $<\boldsymbol{q}_+> >> 0$, and (b) $T_1 < T_2$ for $<\boldsymbol{q}_-> \sim 0$ due to different thermal resistance in different temperature gradient directions.