Solid-state thermionic transport with layered materials

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It has been believed that solid-state thermionic devices cannot perform better than a thermoelectric one made of the same material. This is based on the assumption of zero interfacial thermal resistance and internal electrical resistance. In a real sample these quantities are not strictly zero. Here we propose a structure made of layered materials, which have lately attracted considerable attention because of their electronic properties. Their advantage in the case of thermionic devices is the very low cross-plane thermal conductivity, and availability of a large range of electronic properties making the bandgap tunable. We have performed first-principles density functional theory (DFT) calculations with GGA exchange-correlation functional as well as the GW approximation to properly model electron transport across the device. It was shown that the cooling efficiency could reach values as high as a third of the Carnot value.