Thermal Management and Thermopower Waves by Anisotropic Carbon Nanomaterials

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This talk introduces thermal management and thermoelectric energy conversion researches carried out in my group. Firstly, a recent progress about the grain structure-dependent thermal conductivity characterization of graphene, which was carried out by the optothermal Raman technique, will be discussed. We have achieved high electrical conductivity of polymer matrix composites by employing carbon nanomaterials and silver nanostructures [1-4]. This filler combination was also successful in providing high thermal conductivity (160 W/mK) in applications of polymeric thermal interface materials [5]. Secondly, the concept of thermopower waves, where chemical energy is directly converted into electricity, will be introduced [6]. The exothermic chemical reaction rate of adsorbed fuel could be controlled by anisotropic thermal property of carbon conduits [6,7]. The steep temperature gradient at the reaction front generated thermoelectric power waves [6]. Higher Seebeck coefficient materials have been actively investigated in the past to achieve greater peak voltage and specific power [8]. However, we recently employed the chemical potential gradient as a key mechanism to improve thermal to electrical conversion performance [8]. Unprecedented high maximum peak voltage (8 V) and volume-specific power (0.11 W mm^{-3}) were demonstrated using n-type single-crystalline Bi_2Te_3 substrate and nitrocellulose fuel [8].

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