Title: A Novel Energy-Saving Peltier Cooler Using Thermoelectric Conversion From Low-Temperature Waste Heat

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Low-temperature waste heat is an underutilized resource in industries, and energy-saving technologies can progress through the exploitation of this waste heat. In this study, we developed a method to utilize waste heat generated by Peltier devices by coupling two Peltier devices with a phase change material (PCM). Waste heat from one Peltier device (device A) was stored in the PCM, from which the stored heat was transferred to another Peltier device (device B) and converted into electrical power. The mechanism is as follows: (1) Waste heat from device A converts a portion of the PCM from solid to liquid. (2) The lower density solid rises toward device B, while the liquid component sinks toward device A. (3) Thermal storage occurs through the change from solid to liquid near device A, and heat dissipation occurs from the liquification of the solid near device B. (4) Mechanisms (1) - (3) occur repeatedly, causing the solid-liquid boundary to shirt position, accelerating the movement of waste heat. Use of sodium sulfate decahydrate (Na2SO4 - 10H2O) as the PCM yielded the highest energy conversion efficiency. Based on this mechanism, we adjusted the balance between the thermoelectric conversion of device B and the quantity of heat transferred by the PCM to improve the cooling effect of device A. Finally, we realized a compact, palm-sized Peltier cooler that saves approximately 62% of the plectricity used by conventional Peltier coolers for the same cooling effect