# An Energy Scavenging Thermoelectric Microprocessor Implementation for the Conversion of Waste Heat into Electrical Power

Upadhyaya, Jay (School: Colleyville Heritage High School)

Katta, Ashwin (School: Colleyville Heritage High School)

Thermoelectric generators (TEGs) are devices that use temperature differentials to generate electricity through the Seebeck effect. Low compatibility and efficiency make implementations of TEGs uncommon in consumer devices, resulting in wasted heat and energy. In this research, a commercially available $Bi_2Te_3$ module doped for low temperature (30-200 C°) was implemented on the CPU of a laptop computer (an Intel i3-5005U microprocessor) with a TDP of 15W in order to recover electricity from waste heat. The size of the thermoelectric is well-matched with the CPU such that no structural adjustment is required. A Zinc Oxide based thermal paste compound adhered the hot side to the CPU while simultaneously facilitating heat transfer from the CPU. On the cold side, a hybrid heat sink structure consisting of a silicone-based heat sink adhered to aluminum computer fins was cooled by internal computer fans of negligible power consumption. Results show that thermoelectric implementations into laptop computers can be a viable cost-effective method of extending battery life. Power output under match load was calculated to be ~0.5W (.45A, 1.17V) with an efficiency of ~5.5%. The observed temperature differential varied from 65-75 C°. A cost-benefit analysis reveals that the TEG roughly breaks even over the course of the life of the typical laptop battery, while adding 5.5% to both the single charge and the lifetime of the battery. Theoretical calculations with novel low-cost unicouples reveal that integrations into consumer devices could be made highly efficient, resulting in savings for both consumers and manufacturers.