Anisotropy and Angles: A Novel Approach to Thermoelectric Energy

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As climate change progresses, we must think of new ways to combat this threat. Thermoelectric energy generation, a lesser-known renewable energy source, has the potential of harvesting major amounts of our waste heat. Current technology that achieves this is costly and of low efficiency. I experimented with applying a cheap, novel, overlooked concept: anisotropy-- materials whose physical properties change with angle. I developed an affordable (costing < $50 in total) sintering method, producing 15 anisotropic sintered blocks (and isotropic control). I tested voltage output under a 100 °C temperature gradient and modeled voltage over the increasing angled temperature gradient (225 in initial trials). The best performing anisotropic sintered block, Bismuth-based Copper, produced 146.6 mV. Anisotropic materials proved to be a success, significantly improving voltage output compared to isotropic controls. To better understand my results' implications, I initially theorized and later tested hypothesized proportions to predict the voltage success (300 more trials). After understanding the thermal to electrical conductivity ratio ([mho]) /Wm*K) and detailing sinusoidal trends, I developed an equation to predict the success factor of sintered anisotropic blocks Y=([mho]) /(Wm*K)*(cos([theta])+1.2). I continue to improve the accuracy of this equation with further analysis. Limitations from lack of access to materials (100% remote school) caused errors. While this caused me to improvise many steps in my methods, commitment to the scientific process led me to sufficiently accurate results. I successfully applied the new concept of anisotropy to improve the collection of waste heat from the environment and created a mathematical model that predicts the voltage output success.

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