Dispenser Printed Thermoelectric Power Generators

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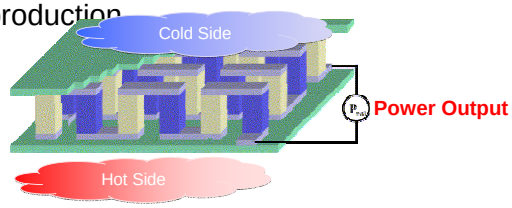
Vision

Thermoelectric generators convert temperature gradients into DC electric power. These generators have shown the potential for powering autonomous sensors from ambient heat sources near room temperature (up to 10 K gradients). They are particularly attractive for implantable medical devices where 1-5 K gradients have been shown to exist in the fat layer of the skin, particularly in the abdomen and the upper back.

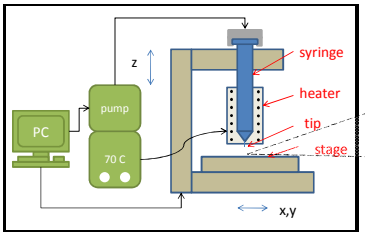
By using optimized geometries, microfabrication allows for maintaining the power output (relative to bulk modules), while utilizing smaller form factors and using less active materias. The optimized geometries are thick film elements (hundreds of microns tall). Existing bulk fabrication methods (extrusion and dicing) as well as traditional microfabrication methods (sputtering and etching) cannot create these structures in a cost effective manner. As a result, we are investigating a new promising printing method, specifically developed to additively create microscale generators. Early results show the method is both cost effective and scalable for the mass production.

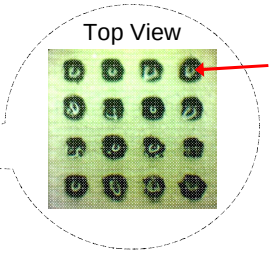


Schematic of a thermoelectric module

Methods

Thermoelectric materials are inherently low voltage, high current sources. To avoid the losses associated with voltage step-up converters, high voltage, low current sources are required. This is made possible by linking many thermoelectric couples with small cross sectional areas in series.The contact dispenser printer is used to print thermoelectric inks containing suspensions of active thermoelectric materials in polymer binders. The inks are filled in prefabricated mold templates as shown above.

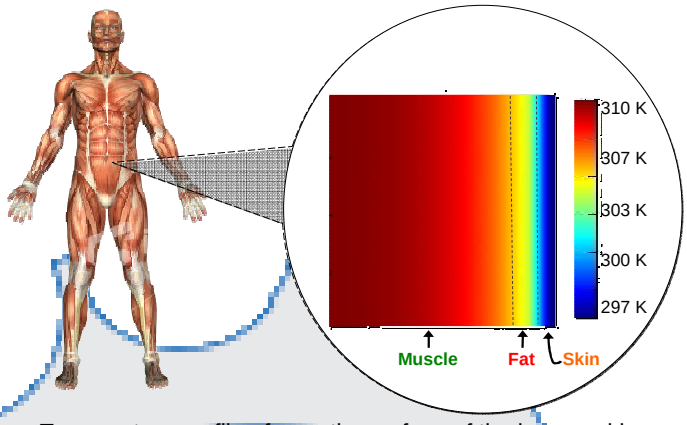




Schematicof the dispenser printer and top view of printed thermoelectric module

Research Questions

1. What is the optimal size factor for the elements when considering low grade waste heat sources?
2. What is the optimal composition of the inks for maximum performace of the generators?
3. Can the fabrication be performed with low temperature processing, or is a high temperature sintering step required?



Temperature profile of near the surface of the human skin

Findings

1. Dispenser printing is a cost-effective method for fabricating micro-sized devices. This work extends the applicability of dispenser printing to thermoelectric generators.
2. Studies have show 1-5 K temperature gradients are available in the human body, which makes microscale thermoelectric generators viable as power sources.
3. Experiments are currently in progress to maximize the efficiencies of dispenser printed thermoelectric generators and will be reported in future work.