

SEMS: RESEARCH PROJECT DESCRIPTION

1. Project Background and Description

Title: Composite thermoelectric materials for energy generation

Thermoelectric materials generate a voltage when placed in a temperature gradient through the Seebeck effect, and this voltage can be harnessed in thermoelectric generators (TEGs) to produce electrical power from waste heat. These materials therefore have enormous potential for meeting part of our energy needs and for enabling self-powered sensors.

However, to enable wider deployment of thermoelectric generators, materials must be developed to (i) improve thermoelectric efficiency; (ii) avoid scarce or toxic elements; (iii) reduce manufacturing costs; (iv) enable conformal devices. A number of advances have enabled these issues to be addressed individually, but no single material addresses all simultaneously. For example, some high performance materials with figure of merit, $ZT > 2$ have been identified, whilst lower performing polymer materials have been addressing costs, abundance, toxicity and flexibility. This project will seek materials that retain the best of both worlds by using hybrid materials. These include organic-inorganic composite materials as well as hybrid crystals such as halide perovskites. The aim will be to use the emerging properties of these hybrids to break the trade-off relationships between thermoelectric properties and enable high performance whilst also addressing the sustainability and scalability of thermoelectric devices.

The project will involve materials development as well as integration of the materials into innovative device architectures.

2. Project Scope

The project objectives are:

1. Develop high performance hybrid thermoelectric materials.
2. Develop methods to process these materials at scale.
3. Design and test low-cost high-performance thermoelectric modules based on these hybrid materials.

3. Desired Skills from the Student

- Experience in any of:
 - Energy materials.
 - Electrical characterization.
 - Materials characterization.
 - Energy devices.
 - Printed electronics.
- The ability to work in a laboratory environment.

Qualifications in any of: Engineering, Materials Science, Electrical Engineering, Physics.

4. Supervisory Team

Primary: Dr Oliver Fenwick

Secondary: Dr Emiliano Bilotti.