Material Interfaces taking Control of Thermoelectric Transport

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Introduction

The presentation begins with a general introduction to the basic thermoelectric transport effect, explains thermoelectric materials in general and their possible applications in thermoelectric devices. In the core part of this plenary presentation, I will discuss the effects of material interfaces on thermoelectric transport in general and select three examples that can lead to tailor-made thermoelectric materials through interface engineering.

1. Many thermoelectric materials are also ionic conductors, which makes these materials thermally instable. As the first example, I will present the improvement of thermal stability and suppression of material diffusion in ZnSb compounds by coating the ZnSb grains using atomic layer deposition technology, which enables conformal coating of nano- and micropowders at the atomic level and subsequent compaction.

2. Thermoelectric multilayer systems are ideal for investigating the influence of the reduced dimension of thin films on electronic and phononic transport separately. We used atomic layer deposition to grow multilayers of Sb_2Te_3 and SbO_x and investigated in detail the significant influence of the interfaces on phonon scattering.

3. Several well-known thermoelectric materials such as Sb_2Te_3, Bi_2Se_3, and Bi_2Te_3 are topological insulators. When these materials are single crystals, the volume of the crystals behaves like a conventional highly doped semiconductor, while the surface behaves like graphene with highly mobile charge carriers. We will show that in nanoscale materials, the topological effects are amplified and can significantly dominate thermoelectric transport in these materials.

In summary, the presentation will bridge the fields of solid-state physics, solid state chemistry, and materials engineering, and I will provide an outlook on the development of material interfaces for future thermoelectric applications.