Title	ナノ構造Cu-Fe-S熱電変換材料のコロイド化学的作成法に関する研究
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Abstract

The research reported in this dissertation work is focused on the synthesis and characterization of the sustainable thermoelectric materials consisting of elements such as copper, iron and sulfur. These elements are earth abundant, less toxic, and inexpensive and acts as building blocks for the fabrication of copper sulfide, iron sulfide, and Cu-Fe-S nanobulk materials for thermoelectric use. These nanoparticles are fabricated using bottom-up/ wet chemical approach which offers the most versatility in terms of control over size, shape, composition and structure of the nanoparticles. Moreover, the bottom-up synthetic technique can be adequately scaled up to create large amount of nanoparticles or nanobulk material for the subsequent thermoelectric measurement. Research work presented in the thesis is based on the synthesis and characterization of chalcogenide, and Cu-Fe-S nanobulk thermoelectric materials.

In chapter 1, I have described background and information about thermoelectricity and choice of thermoelectric materials. A brief review of current status of various thermoelectric materials is given. Research objective will provide the brief information of the work done in this dissertation.

In chapter 2, I have discussed the fabrication of copper iron sulfide nanoparticles by a bottom-up chemical approach. Varying amounts of copper and iron were used to synthesize copper iron sulfide nanoparticles and these nanoparticles with varying composition of copper and iron were fabricated into nanobulk pellet by cold pressed method without applying any special techniques such as pulsed electric current sintering or thermal treatment. Subesquently, their thermoelectric properties were mapped as a function of composition at room temperature and it was observed that on increasing iron content, the power factor decreased. The Seebeck coefficient of the materials reveals p-type conductivity with a maximum value of 203 µV/K at room temperature for Cu/Fe (mol % =30:70).

Chapter 3, I have discussed the fabrication of sustainable Cu-Fe-S nanobulk system for thermoelectrics using Cu_2S and FeS nanoparticles as building blocks. Bottom-up/ wet chemical approach was followed to synthesize Cu_2S and FeS nanoparticles. Varying volume fraction of Cu_2S and FeS nanoparticles were used to obtain different crystal structure of Cu-Fe-S nanobulk material with readily tunable p- to n- type conductivity. Nanobulk material leads to low lattice thermal conductivity ranging from 0.3 to 1.0 W m^{-1} K^{-1}. Blend of 9:1 volume fraction of Cu_2S and FeS NPs gave nanocomposite consisting of bornite Cu_5FeS_4 as the main phase and other minor phases, including nukundamite, digenite, roxbyite, and CuO. This nanocomposite has a maximum dimensionless figure of merit (*ZT*) of 0.55 at 663

K, which is 45% higher than that of pristine bornite Cu_5FeS_4 because of the enhanced power factor and low lattice thermal conductivity (κ_{lat}, 0.3 W m^{-1} K^{-1}).

Chapter 4 describes the structural and thermoelectric property relationship of different Cu-Fe-S system and chapter 5 gives overall general conclusion, and future prospects of the presented research.

Keywords: Thermoelectric, Colloid Chemical Method, Nanoparticles, Sulfides, Sustainable