Thermoelectric Ceramics with Ordered Mesoporous Structure

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Mesoporous materials have a structure containing nano-sized pores of 2~50 nm. Their pore size, pore distribution (regular/irregular, open/close), and pore shape can be controlled easily according to the synthesis process. The existence of pores in the material grants distinctive properties such as decreased dielectric constant from increased porosity and decreased thermal conductivity from increasing phonon scattering. Therefore the mesoporous materials can be used in many applications such as thermal insulators, low dielectrics, thermoelectrics, gas sensors, and so on. Mesoporous materials can be prepared by sol-gel procedure using evaporation induced self assembly (EISA) process and the pore structure including porosity, pore size, and pore distribution could be controlled. The structural, mechanical, and electrical properties of mesoporous materials showed a strong dependency on porous structure. In this presentation, mesoporous ceramic thin films were prepared by using EISA process for applying to thermoelectrics. Thermoelectric properties are defined through the figure of merit, $Z = \sigma S^2/\kappa$, where σ, S, and κ are electrical conductivity, Seebeck coefficient and thermal conductivity, respectively. Therefore high electrical conductivity and low thermal conductivity are desired to enhance thermoelectric property. In this presentation, various experimental approaches including a control of pore structure and introduction of dopants and nano-materials to enhance the thermoelectric property will be discussed. Through the approaches, the authors could control thermal conductivity and electrical conductivity of mesoporous ceramic thin films individually to optimize the thermoelectric property.