Improved Thermo-Electric Efficiency through Decreased Thermal Conductivity due to Engineered Nano-Structures

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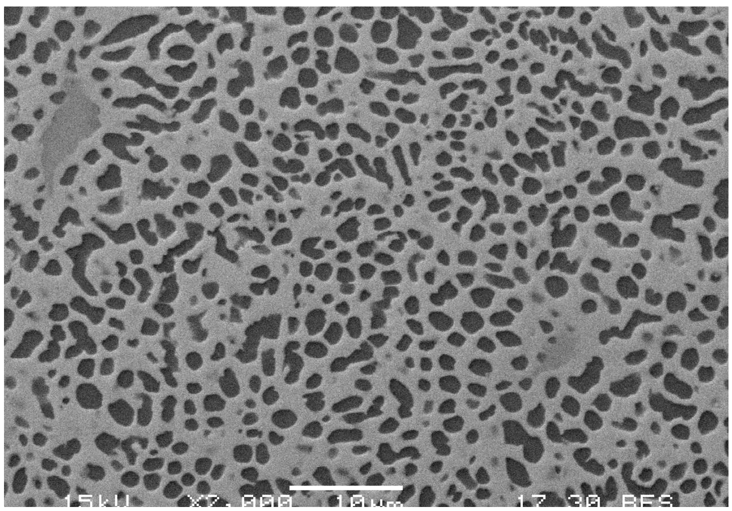
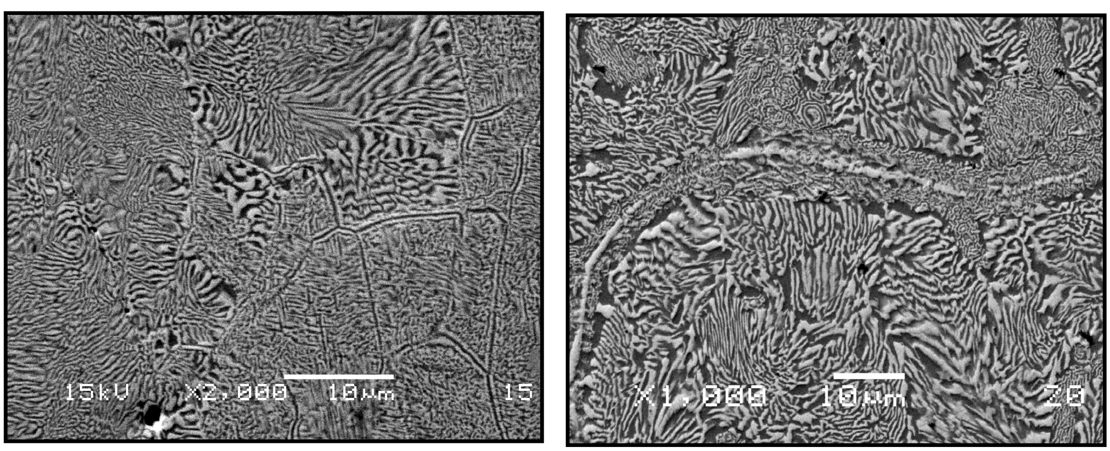
Thermoelectric materials are of great current interest on the background of search for renewable and clean energy sources. The efficiency of thermo-electric devices is so far rather low. One approach for increasing their efficiency is by reducing the thermal conductivity of the thermo-electric materials. This can be done, in principle, by generating a nano-structure with a scale shorter than the mean-free path of the thermal energy carrying phonons.

The thermoelectric Pb-based chalcogenides are known for their elevated thermo-electric properties. The quaternary (Pb,Ge,Sn)Te system undergoes a spinodal decomposition from a high temperature single NaCl –structure phase. By appropriate thermal treatments, it is possible to generate **nano-scale structures** following the spinodal decomposition and, thereby, to decrease the thermal conductivity of the compounds.



Spheroidized submicron and nanostructure following the spinodal decomposition and a lengthy aging treatment in the quasi-ternary (PB.Sn,Ge)Te system. The dark gray island in the upper left corner is the remnant of the undecomposed single high temperature phase.



Lamellar nano-structure following the spinodal decomposition in the in the quasi-ternary (PB.Sn,Ge)Te system. The lamellar microstructure undergoes spheroidization in the course of.lengthy treatments as the result of surface free energy reduction considerations.

Densification of transparent yttrium aluminum garnet (YAG) by SPS processing

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Nano-size YAG powder co-mixed with 0.25 wt.% LiF was used to fabricate transparent polycrystalline YAG specimens by means of the Spark Plasma Sintering (SPS) technique. The presence of the LiF additive in the initial nano-powder allows obtaining fully dense disc shaped (up to 4mm thick) transparent specimens at the outcome of a 2 h treatment at 1300 ◦C. The presence of LiF plays a key role in the mass transport related effects during the densification of YAG to full density and also in the elimination of the residual carbon contamination, allowing reaching a levelof optical transmittance close to the theoretical value.

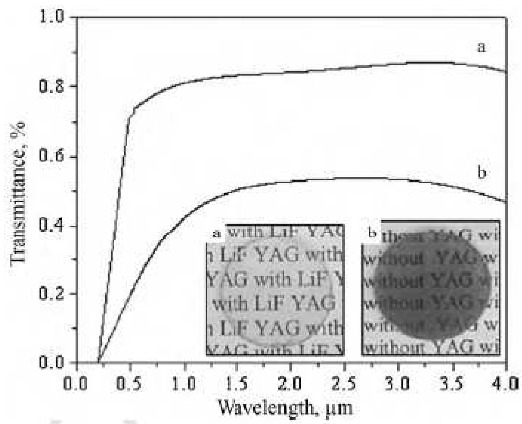
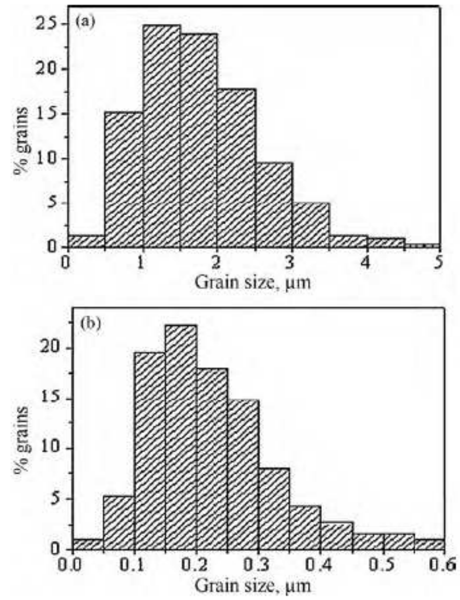


Fig. 9. Optical transmittance of YAG specimens (a) with and (b) without LiF addition. Inserts: the SPS processed samples specimens, 2 mm thick.



Grain size distribution in (a) LiF doped YAG; (b) un-doped YAG.