Scientific Report

INTELBIOMAT Short Visit Grant 3342

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Title: Chalcogenide glasses as potential thermoelectric materials

1- Background

Thermoelectric devices are heat engines that convert thermal energy into electricity and reversibly electricity into heat. Recent approaches to improve performance of bulk thermoelectric (TE) materials show that they should have complex structures, include inclusions and impurities, possess mass fluctuations, disorder and be based on heavy elements. Glasses can possess these properties. In order to identify glasses with interesting TE potential, attention should be focused on small gap semiconducting or semimetallic glasses. Interesting results have already been obtained in the Ge-Te-Cu system in which a huge increase in the power factor is observed, up to a maximum value of 60 $mWK^{-2}m^{-1}$ for the $Cu_{27.5}Ge_{2.5}Te_{70}$ glass at T=300 K [1].
The aim of this stay in Portugal was to investigate new glassy compositions as potential materials for thermoelectric applications, especially the effect of insertion of gallium on the stabilization of Ge-Te-Cu system. The influence of arsenic and antimony in the different compositions on the thermoelectric properties were also investigated.

2- Systems investigated

The glassy systems investigated during this short stay were:

- Cu-Te-As
- Ag-S-Ge
- Sb-Te-Ge-Cu
- Ge-Ga-Te-Cu
- Ge-Te-La_2O_3-Cu

3- Preparation of glasses

Glasses were first prepared by melting the appropriate amount of each element in a vacuumed silica tube at 900°C. After quenching in water, the different glass compositions, mostly unstable against crystallization, were then melt-spinned to obtain small pieces of glass.

4- Characterizations

All the samples were characterized by X-Ray Diffraction and thermal analysis (DSC). The electrical properties (Seebeck coefficient, resistivity, etc) were also measured. These measurements are still in progress.

5- Results

So far, only the glasses of the system Te-As-Cu have been tested for electrical measurements. These compositions show interesting results in terms of power factor (~100 $mWK^{-2}m^{-1}$).

6- Conclusion

This short stay allows us to investigate new glassy systems as potential thermoelectric materials at room temperature. The system Te-As-Cu shows promising results and need further investigations, especially for thermal conductivity measurements. One paper should be submitted.

[1] *"Conducting glasses as new potential thermoelectric materials: the Cu–Ge–Te case"*, A. Pereira Goncalves, E. Branco Lopes, O. Rouleau and C. Godart, *J. Mater. Chem.*, 2010, 20, 1516–1521