Development of multilayer textured $Ca_3Co_4O_9$ materials for thermoelectric generators: influence of the anisotropy on the transport properties

D. Kenfaui[1,2]*, B. Lenoir[1], D. Chateigner[2], B. Ouladdiaf[3], M. Gomina[2], J. G. Noudem[3]

[1] Institut Jean Lamour, UMR 7198 CNRS-Université Lorraine, Parc de Saurupt, 54011 Nancy, France
[2] CRISMAT, UMR 6508 CNRS/ENSICAEN, LUSAC, IUT-Caen and Université de Caen Basse-Normandie, 6 Bd Maréchal Juin, 14050 CAEN Cedex 04, France
[3] Institut Laue-Langevin (ILL), 6 rue J. Horowitz, BP 156-38042 Grenoble, Cedex 09, France

*email of corresponding author: driss.kenfaui@univ-lorraine.fr

Multilayer $Ca_3Co_4O_9$ thick thermoelectric (TE) materials were fabricated by hot−pressing stacked dense and strongly textured single-layer samples. Microstructure and volume quantitative texture investigations were undertaken by using scanning electron microscopy and neutron diffraction techniques, respectively. The results show a bulk density similar to single-layer samples, but remarkable texture strength reinforcement. The electrical resistivity, ρ, and Seebeck coefficient, S, were reproducibly measured in directions parallel (ρ^c and S^c) and perpendicular (ρ^{ab} and S^{ab}) to the mean **c**−axis. ρ showed a high anisotropy ratio $\frac{\rho^c}{\rho^{ab}}$ of 13.5 and 8.8 at 300 and 900 K, respectively, and ρ^{ab} kept the same values whereas ρ^c decreased in the multilayer samples. S^{ab} and S^c unexpectedly revealed different values. The thermal conductivity also displayed a significant anisotropy, with ratio $\frac{\kappa^{ab}}{\kappa^c} = 2.7$ at 900 K. The resulting figure−of−merit ZT is then noticeably anisotropic, with ratio $\frac{ZT^{ab}}{ZT^c} = \mathbf{4.6}$. ZT^{ab} was found 2 times larger than the ZT value of the conventional sintered $Ca_3Co_4O_9$ materials often used for TE modules fabrication.