Laser processing of thermoelectric oxides

N.M. Ferreira, i3N, Physics Department & CICECO – Aveiro Institute of Materials, Department of Materials and Ceramic Engineering, Universidade de Aveiro, Portugal

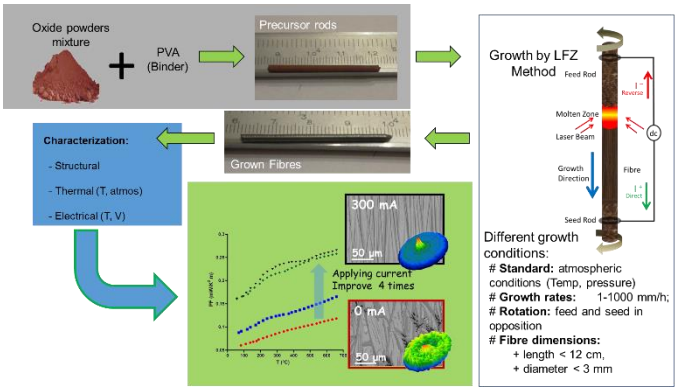
S. Rasekh, ICMA (CSIC-Universidad de Zaragoza), C/Maria de Luna 3, 50018 Zaragoza, Spain
M.A. Madre, ICMA (CSIC-Universidad de Zaragoza), C/Maria de Luna 3, 50018 Zaragoza, Spain
A. Sotelo, ICMA (CSIC-Universidad de Zaragoza), C/Maria de Luna 3, 50018 Zaragoza, Spain
A.V Kovalevsky, Aveiro Institute of Materials, Department of Materials and Ceramic Engineering, Universidade de Aveiro, Portugal
F.M. Costa, i3N, Physics Department, Universidade de Aveiro, Portugal

Abstract (300 word limit)

Ceramic oxides are very promising materials for thermoelectric devices, as they exhibit high Seebeck coefficient and could present relatively low electrical resistivity, as well as high chemical stability at high temperatures. Several oxides exhibit anisotropic thermoelectric properties linked to their layered structures. Therefore, texturing methods developing a preferential grain orientation, like the directional growth from the melt, are suitable to enhance the relevant physical properties. These methods have already shown their applicability to this kind of compounds and also in high Tc superconductor materials, namely, through the use of laser floating zone (LFZ) technique. The LFZ process has demonstrated its suitability for the Co-oxide based thermoelectric materials, processed in the last years in our laboratories.

In this work, some examples of the versatility and usefulness of the LFZ technique are shown. The LFZ technique allows obtaining very dense, homogeneous and well textured thermoelectric composites. The results put in evidence an improvement due to Electrically Assisted Laser Floating Zone on the thermoelectric performances when compared with materials processed by LFZ and by conventional techniques. This technique show also good prospects to be applied in the module construction.

Image



Recent Publications (minimum 5)

1 - N.M. Ferreira, F.M. Costa, A.V. Kovalevsky, M.A. Madre, M.A. Torres, J.C. Diez, A. Sotelo, New environmentally friendly Ba-Fe-O thermoelectric material by flexible laser floating zone processing, Scripta Materialia 145 (2018) 54–57, doi:10.1016/j.scriptamat.2017.10.011

2. N.M. Ferreira, S. Rasekh, A.V Kovalevsky, F.M. Costa, M.A. Madre, J.C. Diez, A. Sotelo, Thermoelectric oxides processed by laser floating zone technique, J. Mat Sci, 5 (2017) 5 DOI: 10.417/2321-6212-C1-005

3. Kovalevsky, A.V., Aguirre, M.H., Populoh, S., Patrício, S.G., Ferreira, N.M., Mikhalev, S.M., Fagg, D.P., Weidenkaff, A., Frade, J.R., Designing strontium titanate-based thermoelectrics: insight into defect chemistry mechanisms (2017) Journal of Materials Chemistry A, 5 (8), pp. 3909-3922, DOI: 10.1039/c6ta09860f

4. A. Sotelo, F.M. Costa, N.M. Ferreira, A. Kovalevsky, M.C. Ferro, V.S. Amaral, J.S. Amaral, S. Rasekh, M.A. Torres, M.A. Madre, J.C. Diez. 'Tailoring Ca3Co4O9 microstructure and performances using a transient liquid phase sintering additive', J. Eur. Ceram. Soc. 36 (2016) 1025.

5. M. A. Madre, F. M. Costa, N. M. Ferreira, S. I. R. Costa, Sh. Rasekh, M. A. Torres, J. C. Diez, V. S. Amaral, J. S. Amaral, A. Sotelo, High thermoelectric performance in Bi2-xPbxBa2Co2Ox promoted by directional growth and annealing, Journal of the European Ceramic Society 36 (2016) 67-74, DOI: 10.1016/j.jeurceramsoc.2015.09.034;

6. Sh. Rasekh, F.M. Costa, N.M. Ferreira, M.A. Torres, M.A. Madre, J.C. Diez, A. Sotelo, Use of laser technology to produce high thermoelectric performances in Bi2Sr2Co1.8Ox, Materials and Design 75 (2015) 143–148, doi: 10.1016/j.matdes.2015.03.005;

7. F.M. Costa, N.M. Ferreira, S. Rasekh, A.J.S. Fernandes, M.A. Torres, M.A. Madre, J.C. Diez, A. Sotelo, Very Large Superconducting Currents Induced by Growth Tailoring, Cryst. Growth Des. 15 (2015) 2094–2101. DOI: 10.1021/cg5015972

8. Sh. Rasekh, N.M. Ferreira, F.M. Costa, G. Constantinescu, M.A. Madre, M.A. Torres, J.C. Diez, A. Sotelo, Development of a new thermoelectric Bi2Ca2Co1.7Ox + Ca3Co4O9 composite, Scripta Materialia 80 (2014), 1–4

9. M.A. Madre, F.M. Costa, N.M. Ferreira, A. Sotelo, M.A. Torres, G. Constantinescu,Sh. Rasekh, J.C. Diez, Preparation of high-performance Ca3Co4O9 thermoelectric ceramics produced by a new two-step method, Journal of the European Ceramic Society 33 (2013) 1747–1754, DOI:10.1016/j.jeurceramsoc.2013.01.029

10. N.M. Ferreira, Sh. Rasekh, F.M. Costa, M.A. Madre, A. Sotelo, J.C. Diez, M. A. Torres, New method to improve the grain alignment and performance of thermoelectric ceramics, Materials Letters (2012), 144-147, DOI: 10.1016/j.matlet.2012.05.131

11. N. M. Ferreira, Sh. Rasek, J. S. Fernandes, F. M. Costa, M. A. Madre, J. C. Diez, A. Sotelo; Electrical Polarization Effect on Bi2Ca2Co1.7Ox thermoelectrics grown by laser floating zone; Microscopy and Microanalysis, 18 (2012) 93-94, DOI: 10.1017/S1431927612013128.



Biography (150 word limit)

Nuno Ferreira, is a PhD in Physics Engineering (2014), currently is a post-doc researcher at i3N, Physics Department and CICECO, Department of Materials and Ceramic Engineering at University of Aveiro, Portugal. He had participated as a collaborator and research fellow in several R&D projects on material science. He is an experienced researcher in study and development of ceramics-based materials, prepared through conventional methods (melting, solid stated), with particular focus on laser processing (crystal growth – LFZ and surface sintering). Present skills on sample characterization including various techniques such as, electrical and magnetic properties of various oxide materials. Current focus materials: thermoelectrics, ferroelectrics and glass matrices doped with transition metals and rare earth for energy storage and conversion applications. Main expertise is related to structural, magnetic and electrical properties of materials prepared by laser processing.

Email: nmferreira@ua.pt

Notes/Comments: