



Citation for published version:

Roscow, J 2015, 'Modelling Porous Ferroelectrics to Assess Piezoelectric Energy Harvesting Capabilities', 13th European Meeting on Ferroelectricity, Porto, Portugal, 29/06/15 - 3/07/15.

Publication date:
2015

Document Version
Publisher's PDF, also known as Version of record

[Link to publication](#)

University of Bath

Alternative formats

If you require this document in an alternative format, please contact:
openaccess@bath.ac.uk

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Modelling Porous Ferroelectrics to Assess Piezoelectric Energy Harvesting Capabilities

J. I. Roscow, R. W. C. Lewis and C. R. Bowen. Email: j.i.Roscow@bath.ac.uk

Aim: To evaluate the effect of porosity and porous structure on the energy harvesting capabilities of ferroelectric ceramics using a Finite Element Modelling approach.

Context

Porous piezoelectric ceramics are of interest for energy harvesting applications due to porosity causing significant reductions in permittivity, ϵ_{33} , compared with relatively small reductions in longitudinal strain coefficient, d_{33} , leading to increases in energy harvesting figures of merit, where $FOM_{33} = d_{33}^2/\epsilon_{33}$ [1]. The development of an FE Model will allow different porous structures to be evaluated for their energy harvesting capabilities.

Pre- and Post-Poling Porous BaTiO₃ network

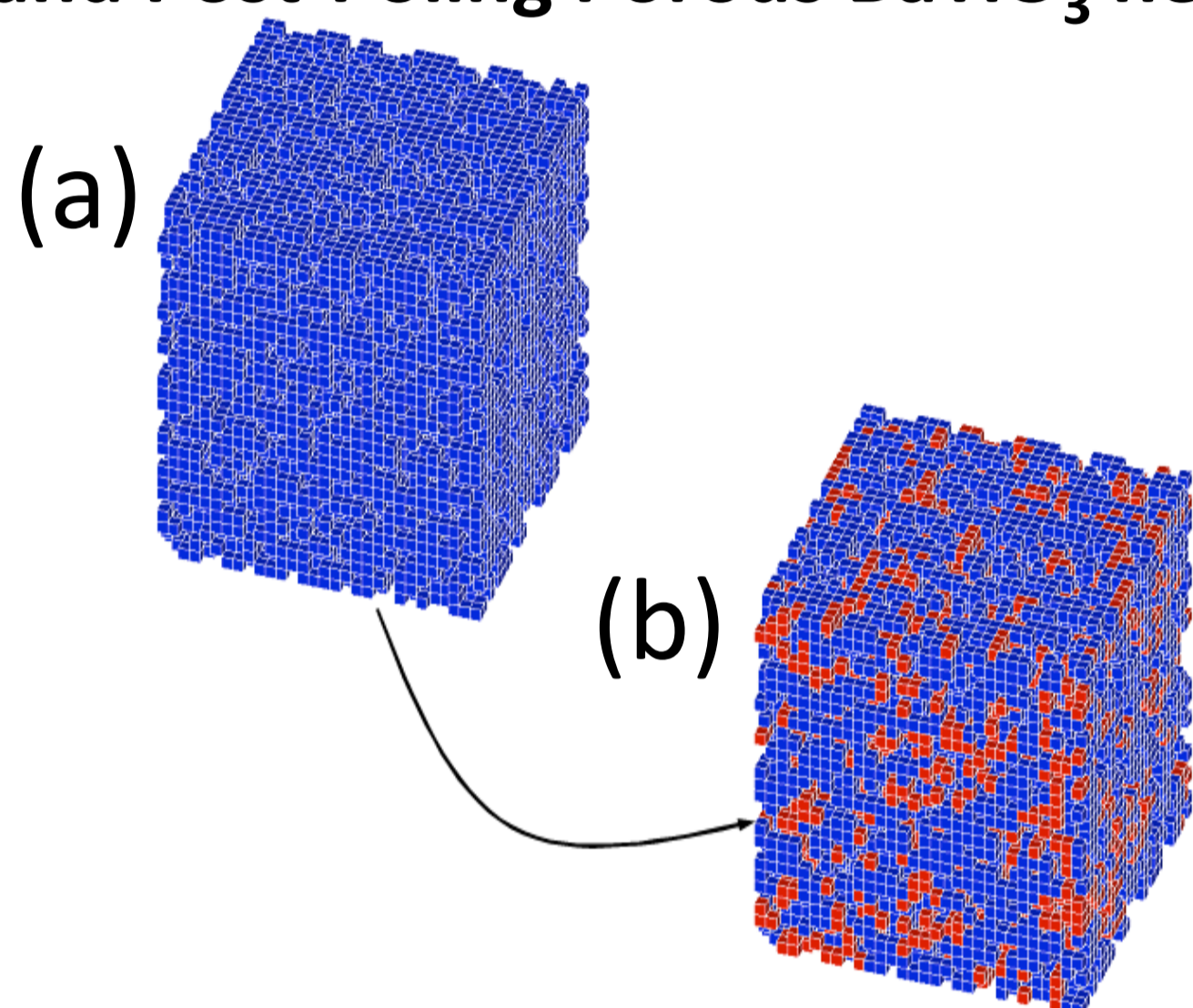


Fig. 1: (a) 30^3 cells randomly designated material properties of either unpoled BaTiO₃ (blue) or air (empty), depending of density defined for run and (b) post-poling procedure with poled (red) and unpoled BaTiO₃ (blue) and air (empty). BaTiO₃ elements are poled when local E-field exceeds coercive field.

FE Modelling Process

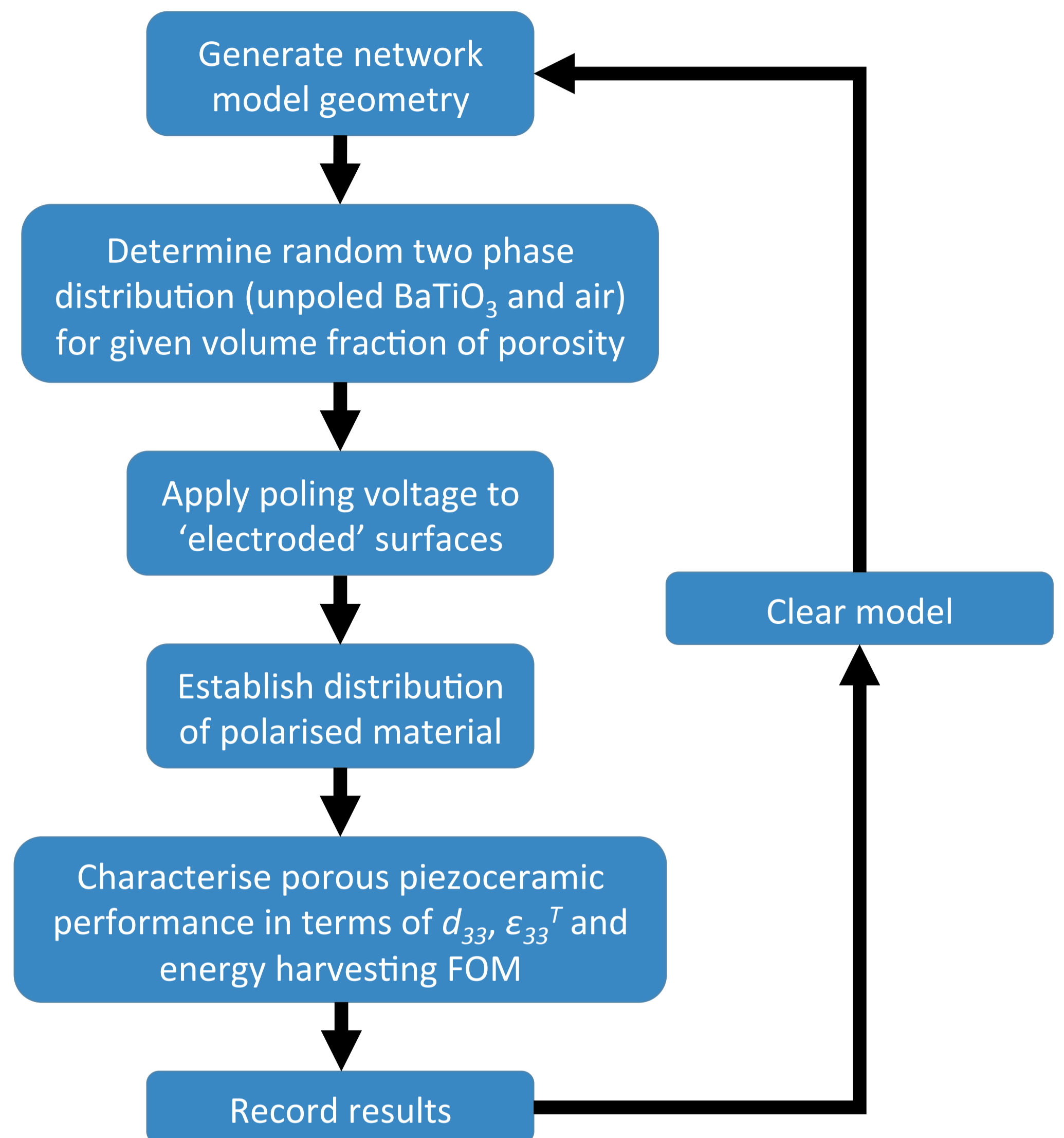


Fig. 2: Flow diagram of modelling process used to generate randomly distributed porosity with piezoelectric ceramic (adapted from [2])

Initial Results

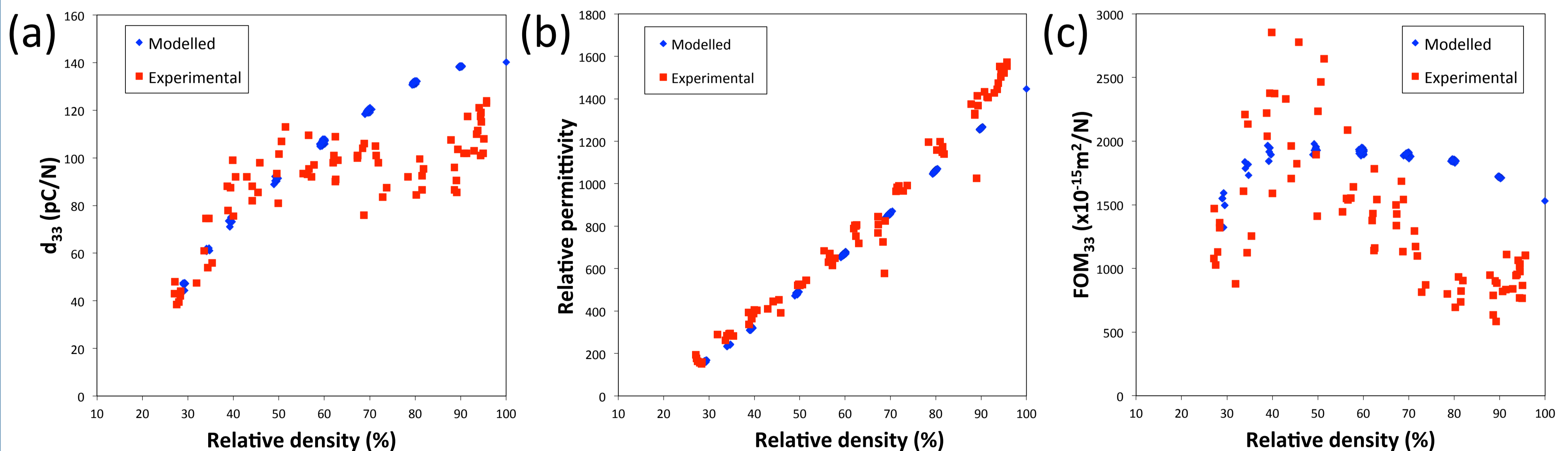


Fig. 3: FE model data (blue) compared to experimental data BaTiO₃ (red) for (a) d_{33} , (b) relative permittivity and (c) FOM_{33} , all plotted as a function of relative density. Experimental data measured from BaTiO₃ ceramics with range of porosities obtained using the burned out polymer spheres (BURPS) process.

Discussion & Outlook

- Want to bring model and experimental data closer together
 - More accurate input data required
- Use model to investigate EH capabilities of different structures/connectivities
 - Currently, only randomly distributed porosity (3-0/3-3) generated
 - Structure has effect on key properties, i.e. d_{33} , ϵ_{33} and S_{33}^E (elastic compliance)

Acknowledgement

The research leading to these results has received funding from the European Research Council under the European Union's Seventh Framework Programme (FP/2007-2013) / ERC Grant Agreement no. 320963 on Novel Energy Materials, Engineering Science and Integrated Systems (NEMESIS).

References

- [1] Islam, R. A., & Priya, S. *J. Am. Ceram. Soc.*, 2006, **89**, 3147–3156.
- [2] Lewis, R. W. C., Dent, A. C. E., Stevens, R., & Bowen, C. R. (2011). *Smart Mater. and Struct.*, 2011, **20**, 085002.