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Condensed Method: A new scale–bridging approach

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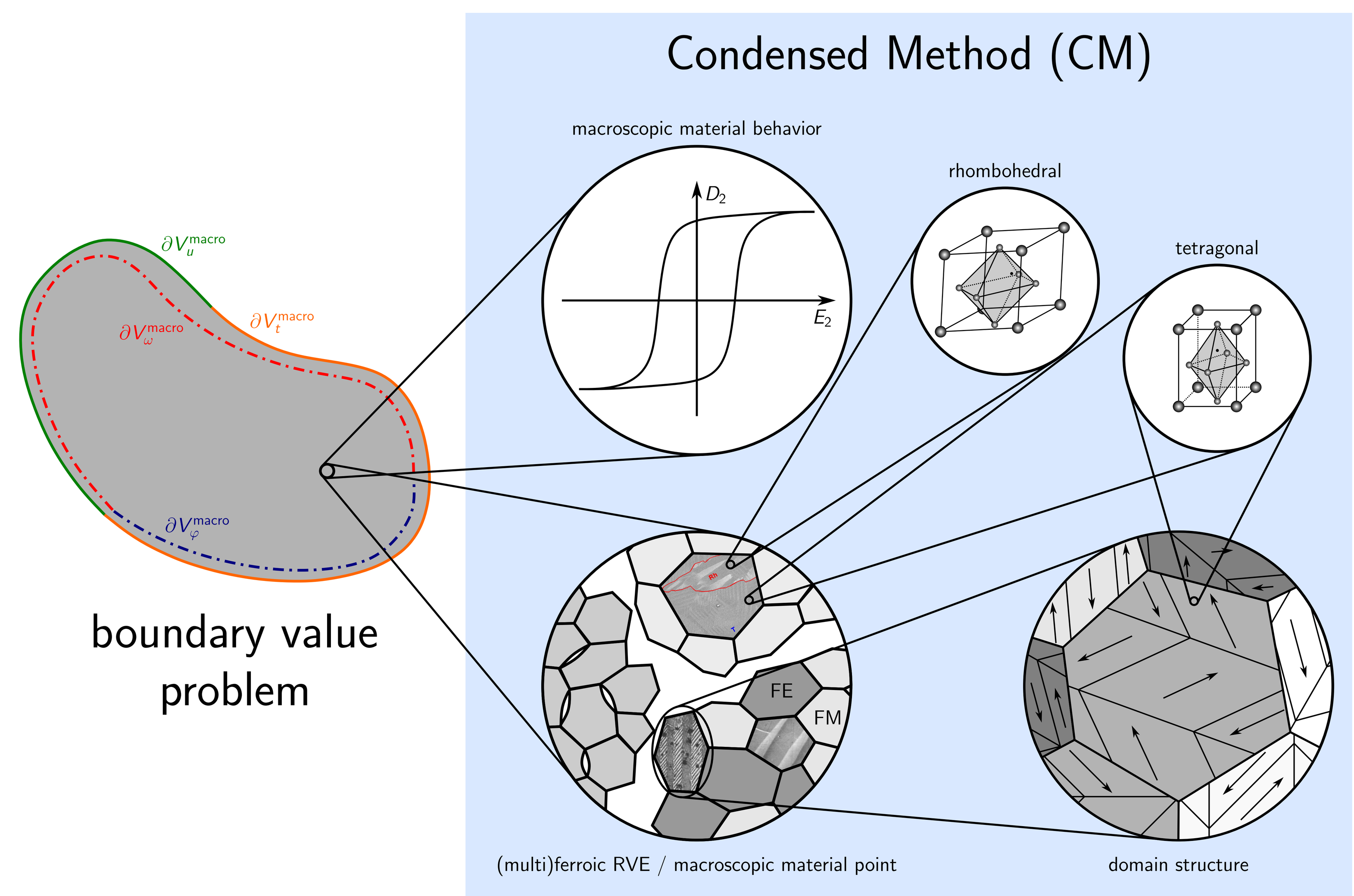
Motivation

The condensed method (CM) is a new homogenization and scale–bridging approach, where the macroscopic material behavior of a multigrain, multiconstituent or multiphase system is represented at a material point. It provides an efficient framework for the development of constitutive equations, starting from a microscopic level, e.g. of ferroelectric domains, and ending up with a mesoscopic volume element, appropriately accounting for interactions between the microscopic constituents. The CM enables to investigate e.g. multiphysical hysteresis behavior, residual stress development and damage evolution or dissipation heating.

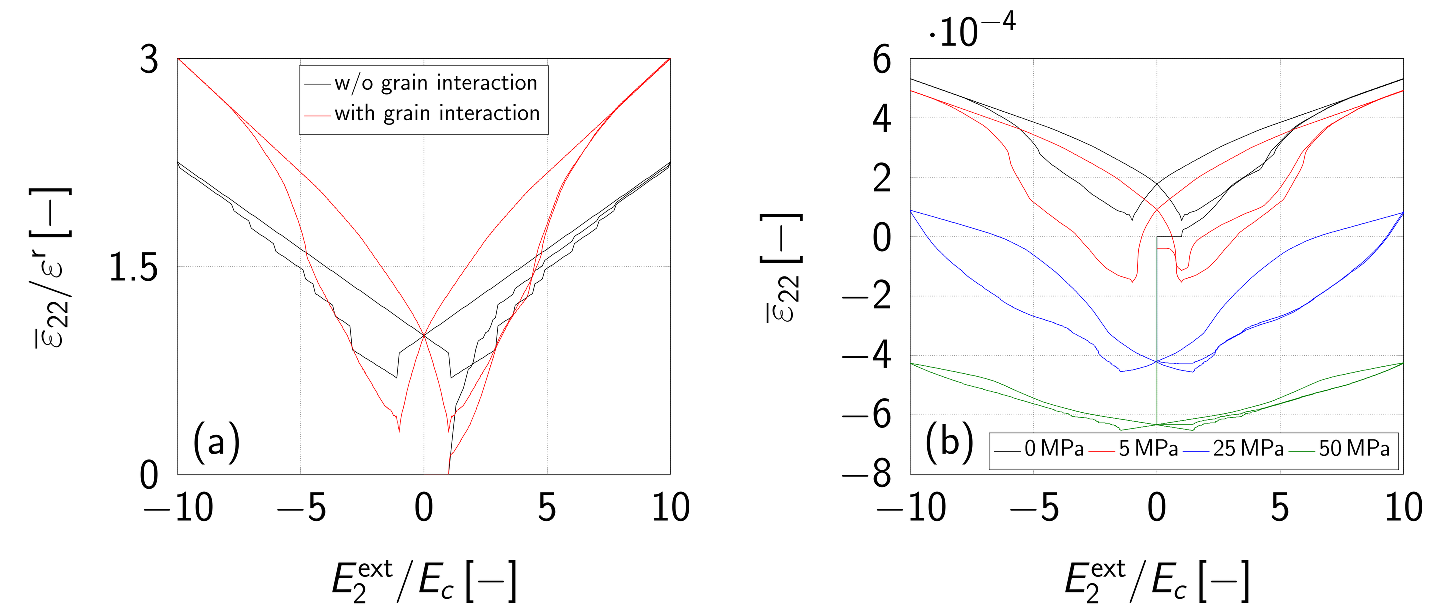
Condensed Method



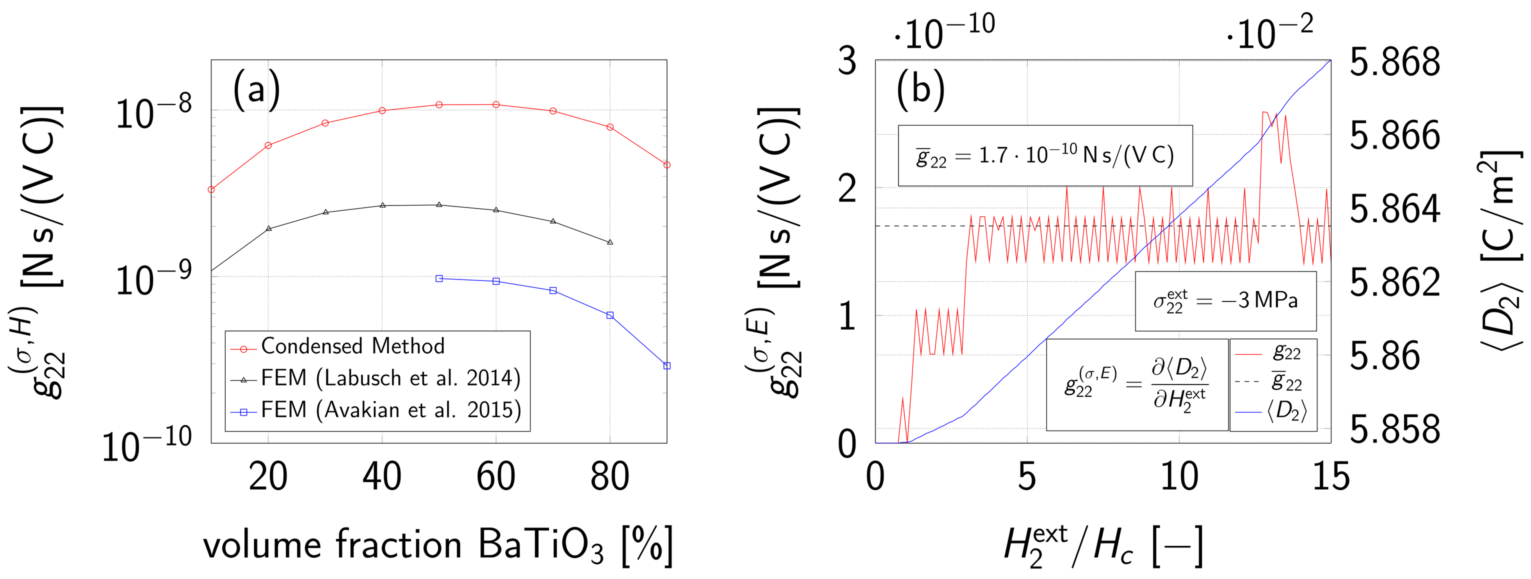
SEM pictures taken from: Arlt 1990, Egelkamp and Reimer 1990, Scholehwar 2010

Results

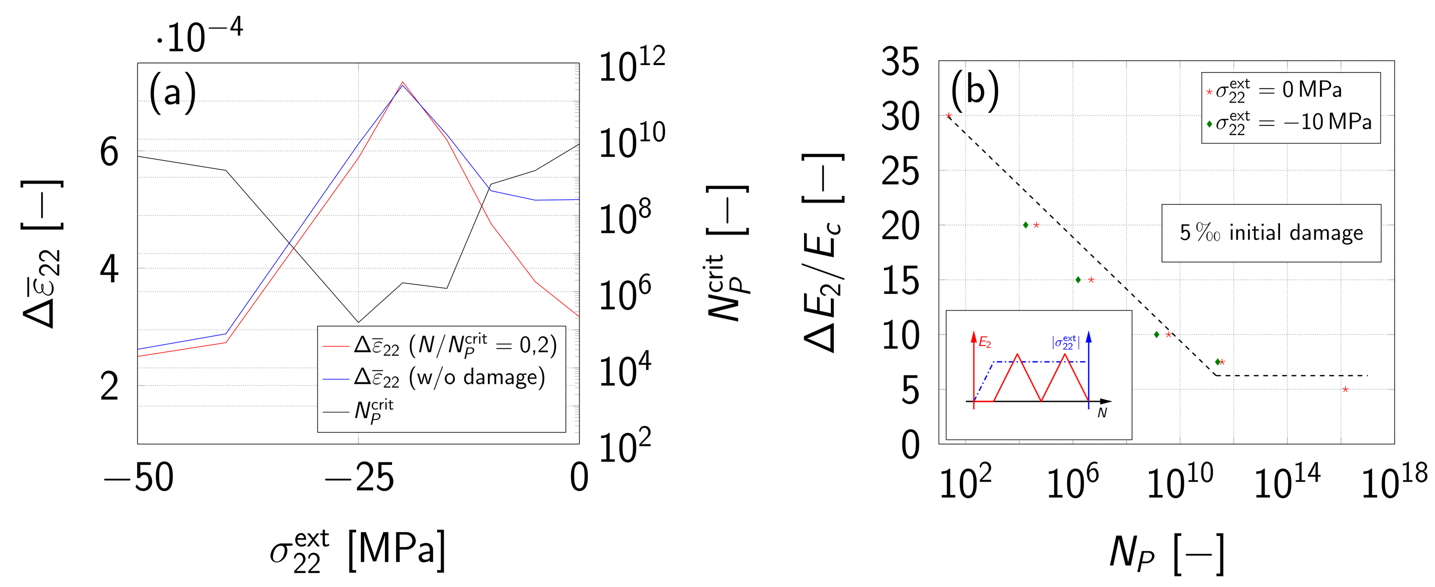
Influence of grain interaction (a) and compressive preload (b) on the butterfly loop of strain versus electric field:



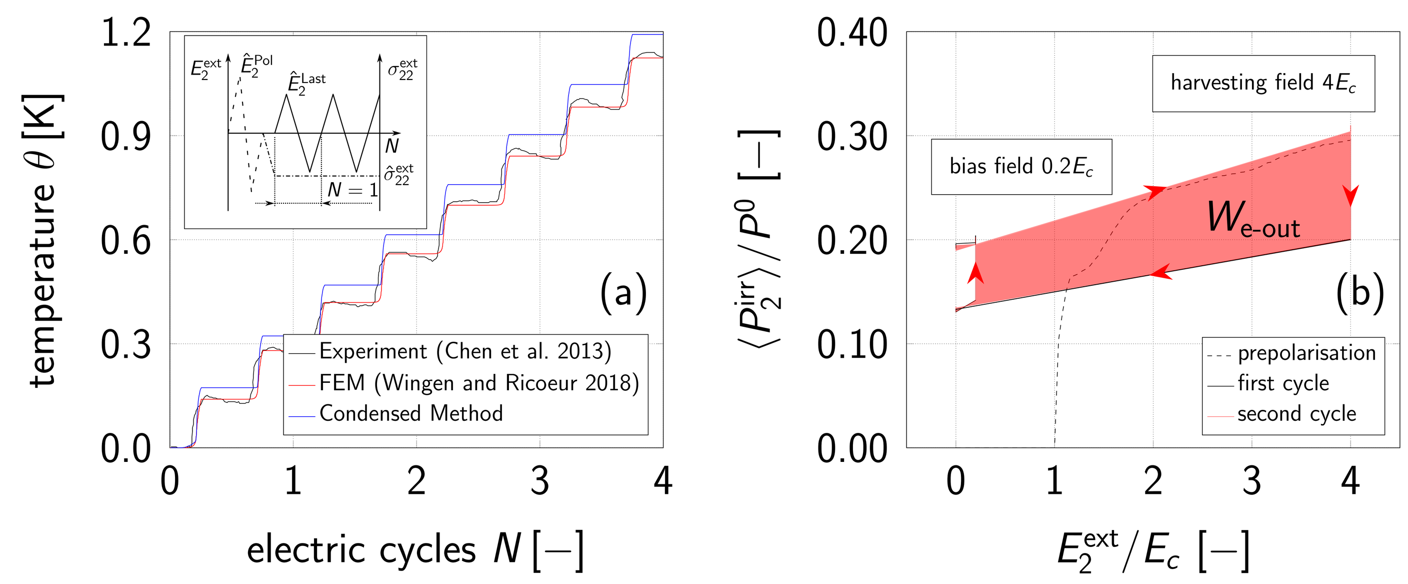
Investigation of the magnetoelectric coupling coefficient g_{22} of a multiferroic particle composit. Linear (a) and nonlinear (b) material behavior:



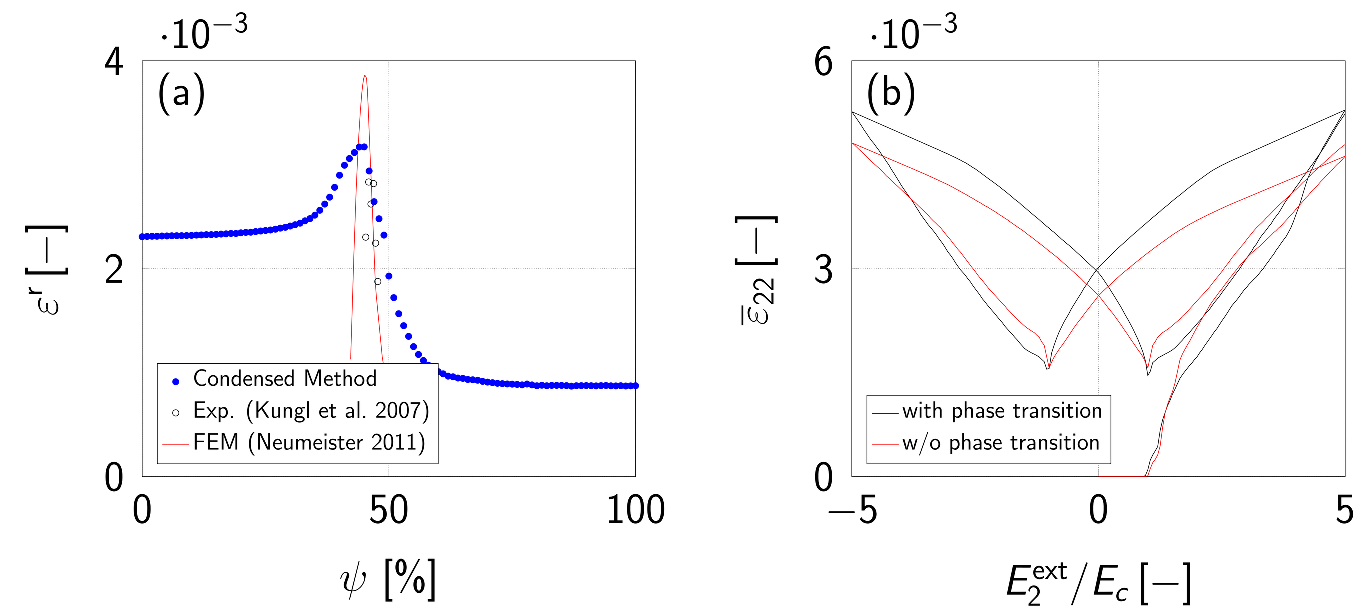
Influence of compressive load $\sigma_{22}^{\mathrm{ext}}$ on life span N_P^{crit} and strain of a ferroelectric actuator (a); Wöhler–type diagram for electric cycling (b):



Dissipation heating during electric cycle (a); ferroelectric energy harvesting with bias field to control repolarisation process (b):



Influence of the chemical composition ψ of $Pb(Zr_{1-\psi}Ti_{\psi})O_3$ on remant strain ε^{r} (a) and influence of phase transitions on the butterfly loop (b):



References

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- Research Associate (University of Kassel)
- Research interests
  - Smart Materials
  - multiscale problems