# X-ray Studies of Strain Behaviour in Magnetoelectric Composites

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Magnetoelectric composite materials are promising candidates for highly sensitive magnetic-field sensors. Exploiting a range of X-ray diffraction methods [1-3], we have succeeded to directly determine magnetic and electric field induced strain at the interface of these magnetoelectric composites. We show that both geometry and sample growth play an important role in strain behaviour.

High resolution grazing incidence diffraction was used to determine magnetic field induced strain at the Metglas/ZnO planar interface showing the saturation strain along [1-10] of about $3x10^{-5}$ [1]. Additionally, nanofocus X-ray diffraction enabled the local mapping of the magnetoelectric microcomposite properties of ZnO microrods coated with amorphous Metglas. Here, in addition to the expected magnetic field induced strain, we observe a strong enhancement resulting in strain up to $10^{-5}$ in the ZnO at the interface [3].

In a further X-ray diffraction study we have investigated the elastic coupling of electrically induced strain in similar epitaxial multiferroic interfaces - PMN-PT substrate and a $CoFe_2O_4$ layer. Although the coupling at epitaxial interfaces is expected to be 1, we obtained a value of ~86 %, this surprising result can be explained by strain relaxation at grain boundaries. The non-perfect coupling in this epitaxial system can be explained by grain boundary relaxation.

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a) b)

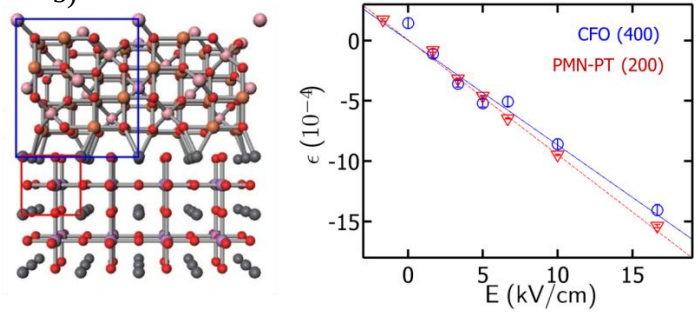


Figure1: a) Atomic CFO/PMNPT interface. b) Strain as a function of increasing electric field.

## References

1. M. Abes *et al.*, *App. Phys. Lett.* **102**, 011601 (2013).

2. M. Abes *et al.*, *J. App. Phys.* **113**, 124303 (2013).

3. S. B. Hrkac *et al.*, *App. Phys. Lett.* **103**, 123111 (2013).