ON THE USE OF PIEZO-SUBSTRATES: REVERSIBLE ELASTIC FILM STRAIN FOR ENGINEERING ELECTRONIC PROPERTIES

tutorial

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Abstract

Thin films in applications are always strained, even without epitaxy on a crystalline substrate, because of the different thermal expansion of films and substrates. Originally just a nuisance, elastic film strain has developed into an efficient tool for engineering materials.

Measuring the strain response of electronic properties is, thus, of vital significance. About 15 years ago, piezoelectric substrates have been introduced for direct strain control during experiments on thin films. Straining thin film heterostructures on piezo-substrates just requires an electric voltage, since the inverse piezoelectric effect of the substrate is exploited.

I will discuss the use of piezo-substrates in magnetoelectric heterostructures where magnetic order is controlled by an electric field. Further, the reversible strain has been successfully utilized for semiconductor nanomaterials (InGaAs quantum dots, 2D materials) adjusting (single) photon emission for quantum optics. The most common piezo-substrates are made from ferroelectric (relaxor) crystals of PMN-PT ((1-x)PbMg1/3Nb2/3O3 - xPbTiO3) which will be introduced briefly. Nanoscale responses of electronic and optical properties to in-situ reversible elastic strain investigated by force microscopy and x-ray absorption / scattering techniques opens a wide future research field.

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