CEA - Saclay 91191 Gif-sur-yvette Cedex
Service de Physique de l'Etat Condensé - UMR 3680

SÉMINAIRE SPECIALISE

Jeudi 23 novembre 2017 à 11h 15

Orme des Merisiers SPEC, Salle Itzykson, Bât.774

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Light on ferroelectric oxide thin films

The integration of functional oxides in epitaxial films on silicon is an actual challenge to develop innovative microelectronic devices by taking advantage of the rich variety of their physical properties. Among oxides, ferroelectric oxides are particularly promising thanks to the wide range of functionalities such as electrical polarization, piezoelectricity or photovoltaic effect, as well as their potential coupling. In particular, ferroelectric oxides are widely exploited in microelectromechanical systems (MEMS).

In this context, photostriction is an original physical mechanism inducing a non thermal elastic deformation under illumination [1, 2]. This effect has been explored in a couple of ferroelectric oxides in ceramics [3] or single crystals [4] but remains poorly understood and with too long response time for developing devices. The recent studies in ferroelectric thin films [5, 6] have reported photoinduced deformation in the psec time range, opening thus a new route for ultrafast strain engineering and ultrafast optical actuation in devices. However, in these experiments, the polarization was in the as-grown state, so its contribution on the photostrictive response could not be studied. Photostriction which can be described as a combination of the photovoltaic effect (photogeneration of electron-holes pairs under light) and the inverse piezoelectric effect (mechanical deformation under electric field) is a complex mechanism which deserves a better understanding in order to enhance photostrictive performance.

In this seminar, I will present our recent results on ultrafast photoinduced strain in ferroelectric thin films based devices with an in situ control of the polarization state. PZT thin films have been grown by pulsed laser deposition on SrRuO3-buffered SrTiO3 substrates and integrated in capacitor structures using different steps of patterning in cleanroom. Their ferroelectric, piezoelectric and photovoltaic properties have been studied by different characterization techniques, as well as their conduction mechanisms, revealing clear effects from interfaces with electrode. Finally, pump-probe X-ray diffraction measurements have been performed on the devices and allowed to investigate the contribution from depolarizing field and imprint field on the photostriction magnitude.

[1] Photostrictive materials, B. Kundys, Applied Physics Reviews 2015
[2] Photovoltaics with ferroelectrics: current status and beyond, C. Paillard et al., Advanced Materials 28, 5153 (2016)
[3] Photostrictive actuators, P. Poosanaas, et al. Mechatronics 10, 467 (2000)
[4] Light-induced size changes in BiFeO3 crystals, B. Kundys, et al.Nature Materials 9, 803 (2010)
[5] Ultrafast photovoltaic response in ferroelectric nanolayers, D. Daranciang, et al. Physical Review Letters 108, 087601 (2012)
[6] Electronic origin of ultrafast photoinduced strain in BiFeO3, H. Wen, et al.Physical Review Letters 110, 037601 (2013)

The seminar will be given in English.

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