ESRF	**Experiment title:** Study of the strain field and local elastic to plastic transition in HgCdTe photodiodes under external stress	**Experiment number**: 32-02-798
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Names and affiliations of applicants (* indicates experimentalists):

Dr Aymeric Tuaz* - CEA-Grenoble / LETI / DOPT / STM / LMS

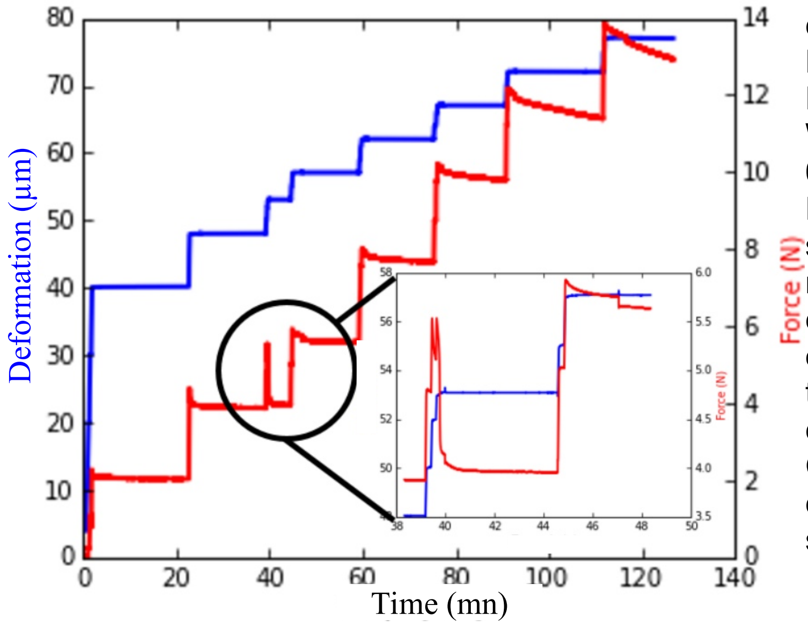
Dr Habil Philippe Ballet* - CEA-Grenoble / LETI / DOPT / STM / LMS

Dr Ing Habil Xavier Biquard* - CEA-Grenoble / IRIG / DEPHY / MEM / NRS

Report:

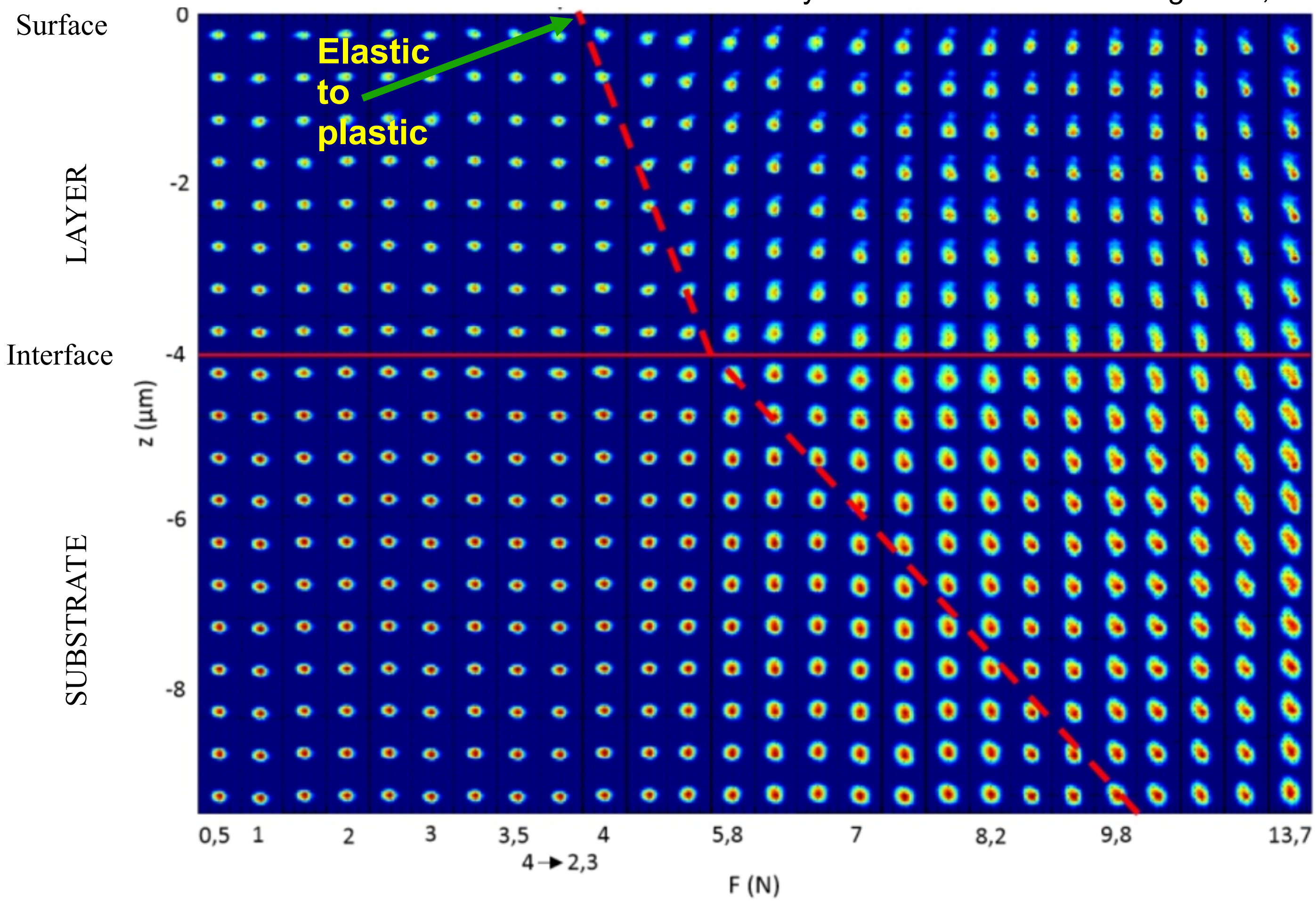
In order to mimic and thus study the technological processing-induced strain during the fabrication of IR photodiode, a four points bending machine is used to reproduce the strain built-up during each fabrication step. The main purpose of this proposal is to analyse with a sub-micrometer resolution, the strain field distribution inside HgCdTe layers induced by an external applied stress, including the elastic to plastic transition as it directly correlate with device performance.

We expect to understand the strain behaviour within the HgCdTe layer using different external applied stress and growth techniques. This will be of valuable help for the design of HgCdTe detectors and optimization of their performances. And indeed, this study provides us with all expected results which constitutes the full chapter 6 of the successfully defended PhD of A. Tuaz [1]. Here follows a brief English summary of this chapter.



We used a 15x4 mm^2 MBE sample with a 0.02% mismatch between the 4µm thick HgCdTe layer and CdZnTe substrate. The sample is measured in the deformation mode where force is increased until chosen deformation is reached. Given our experimental parameters, the 15 MPa tensile elastic limit of HgCdTe [2] corresponds to a 3.5 N force while for bulk CdZnTe substrate, the 60 MPa elastic limit corresponds to 15 N. And indeed as shown in Figure 1, a spontaneous relaxation occurs around 3.5 N (see insert), demonstrating elastic to plastic transition of the HgCdTe layer.

This elastic to plastic transition is also clearly visible on the diffraction peak shape. Indeed, while inside the elastic domain, all diffraction peaks are well-shaped and nicely round. But in the plastic domain, they become quite deformed. Figure 2 shows the shape evolution of the [77-1] diffraction peak for all measured force as a function of beam position along the sample height: the elastic to plastic transition occurs around 3.5 N at the surface of the layer. When further increasing force, the



plastic transition (represented with a dashed red line) propagates deeper into the sample until the layer/substrate interface is reached at 5.8 N. Then surprisingly, plastic transition continues inside the substrate despite a 15 N force is required for this transition to initiate inside bulk CdZnTe. This indicates that our layer has considerably lowered the elastic limit of the substrate: we believe this comes from a substrate plastification initiated and facilitated by the presence of layer dislocations at the interface, a situation that doesn't occur when testing the bulk substrate material alone. We also observe that the plastification front slope is much smaller inside the substrate than the layer thus illustrating the much higher stiffness of our substrate compared to that of the layer.

<u>Références :</u>

[1]: A. Tuaz, 'Investigations structurales haute-résolution de photodiodes infrarouges de nouvelle génération', phdthesis, Université Grenoble Alpes - CEA/Grenoble, Grenoble, 2017.

[2] P. Ballet, X. Baudry, B. Polge, D. Brellier, J. Merlin, and P. Gergaud, 'Strain Determination in Quasi-Lattice-Matched LWIR HgCdTe/CdZnTe Layers', Journal of Elec Materi, vol. 42, no. 11, pp. 3133–3137, Nov. 2013, doi: 10.1007/s11664-013-2682-0.