[MS26 - 03] Strain characterisation in Nano-crystalline ceramics: The Laser pump-probe technique

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In many applications materials suffer repeated dynamic strain cycles, including various materials ranging from semiconductors (photovoltaic absorber layers) to fuel cell electrolytes and refractory bricks. These cycles of incident strain cause shockwaves which propagate throughout the bulk. These shockwaves can leave behind defect states in the material causing minor residual strain. However, as the number of defect states increases, this minor residual strain becomes significant[1]. This experiment utilized the mythen position sensitive detector on beamline I11 at Diamond to take very short exposures of the sample (1ms) during strain propagation [2] . Strain was generated in granular alumina-zirconia based ceramics using a 125W CO2 laser set to use a very short burst of light designed to simulate a 'shock'. Both laser and detector were triggered by a pulse generator which allowed for very short tuneable delays (~μs) between shock and exposure. The distance of the exposure site from the shock site was varied in order to monitor the magnitude w.r.t the distance from the shock site. Due to the small number of incident photons available on such short timescales, the resulting 1ms exposures are then summed together. These summed exposures form longer ~1s diffraction patterns which contain appropriate statistics for analysis. Topas academic was used to analyse the patterns using a Pawley-LeBail fit. Preliminary results show that at a shock/exposure time delay of 10μs, the most intense point of strain is not at the shock site, but approximately 1mm away. This indicates that the strain observed is dominated by the shockwave rather than by thermal expansion, which would cause maximum strain at the laser impact site. Further analysis shows preferential expansion of the unit cell in both directions 'a' and 'c' of the monoclinic zirconia phase. The cause of these directions being preferentially effected is to be investigated with further analysis of the data.

[1] P. Ballard, J. Fournier, R. Fabbro and J. Frelat. Journal De Physique III C3-01 (1991) 487-494
[2] S. P. Thompson, J. E. Parker, J. Potter, T. P. Hill, A. Birt, T. M. Cobb, F. Yuan, and C. C. Tang. AIP Rev. Sci. Instrum. 80, (2009) 075107

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