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Evaluation of the depth extension of the damages induced by FLASH pulses in silicon crystals

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The development of new generation of short radiation sources exploring free electron lasers focussed the interest in the problem of the interaction of the beam generated by these devices with solid matter. The strong excitation of electronic state induced by the beam can here reveal a number of new phenomena, which are important for practical development of optical elements and design of experiments, but also seems to be very interesting in cognitive aspects. The information about the phenomena requires a very careful structural characterization of the craters especially their geometrical features and the lattice deformation.

In our previous experiment the use of back reflection section and projection topography enabled us to reveal many important features of the strain fields connected with the craters. It was in particular possible to demonstrate a significant similarity of the observed strain field to that of rod-like inclusion. The last results seemed to suggest unexpectedly large depth extension of the strain field connected with the craters.

In the present experiment we performed a successful attempt to confirm this observation by taking the synchrotron transmission section white beam topographs using the beam perpendicular to the surface of the sample. Numerous relatively dense series of section topographs spaced by 10 μm provided a kind of a precise scan allowing the evaluation of geometrical shape and depth extension some various craters offering also the possibility of comparing the images corresponding to the reflection from different crystallographic planes. In the obtained topographic images we observed the direct image connected with the boundary of the crater accompanied by the some deformation of the Kato fringes. The representative transmission section topograph chosen from the large series is shown in fig. 1.

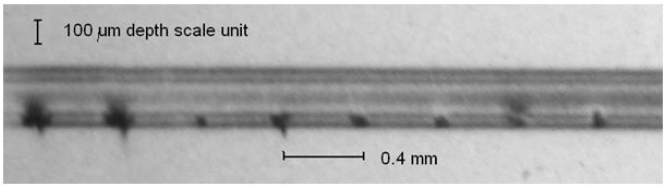

Fig 1 The representative synchrotron topograph, exposed with the beam perpendicular to the sample with FLASH induced craters, chosen from the exposed series to provide the highest extension of their direct images.

The evaluated depth extension was slightly differed for individual craters and was in the range 30 – 100 μm. This value was confirmed also by some evaluations basing on the vanishing the images of the series of spots in the Bragg case section topographs obtained when the beam entered the crystal at low 4º angle.

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