	Experiment title: Characterization of zone plates for the European TWINMIC project	**Experiment number**: MI 578
Beamline: ID21	**Date of experiment**: from: 20/06/02 to: 24/06/02 from: 22/07/02 to: 26/07/02	**Date of report**: 30/08/2002
Shifts: 12+12	**Local contact(s)**: Dr. Remi TUCOULOU TACHOUERES, Dr. Olivier DHEZ	*Received at ESRF:*

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Report:

TWINMIC is an European project that aims at building a next generation twin X-ray microscopy station combining full-field imaging and scanning type X-ray microscopes. The project, which includes three European synchrotron light sources (ELETTRA, ESRF and SLS) as well as institutions and laboratories that mastered state-of-art X-ray microscopy and nanofabrication, has one objective to optimize imaging performance of conventional diffractive X-ray optics and to extend their application to novel phase sensitive technologies based on modern approaches of nanostructuring and better understanding of X-ray optical imaging properties. Important part of the scientific and technical case of the generation of the twin microscope station is the development of novel zone plates (ZPs) adapted to the coherence of third and higher generation X-ray sources, spatial resolution, different contrast techniques and imaging modes in transmission or photo-emission. The multi-functionality, versatility and adaptability of diffractive optical elements with the capability to combine different imaging modes is demonstrated in the experiment MI 578: New theoretical modeling and modern nanofabrication of X-ray diffractive elements specially developed at TASC/INFM at ELETTRA allowed to combine two conventional zone plates creating two spherical waves for differential interference contrast (DIC) imaging into a single, 2-spot creating diffractive optical element without any loss in image performance compared to conventional ZPs generated during the same nanofabrication procedure of the X-ray optics as shown in Fig. 1.

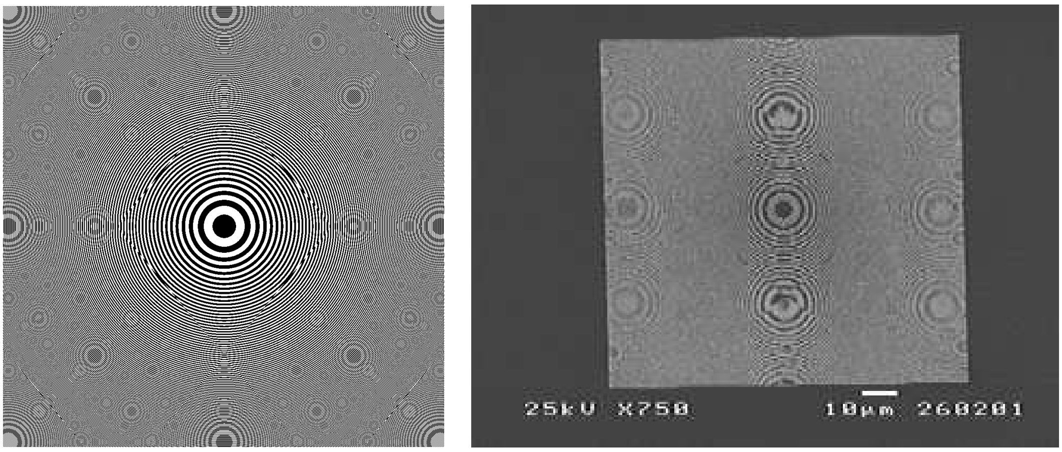
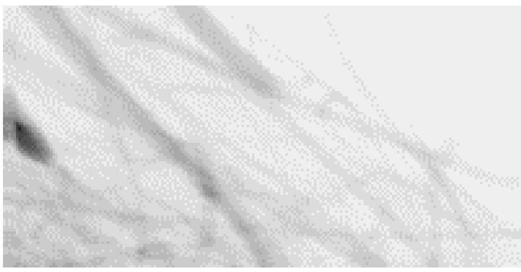
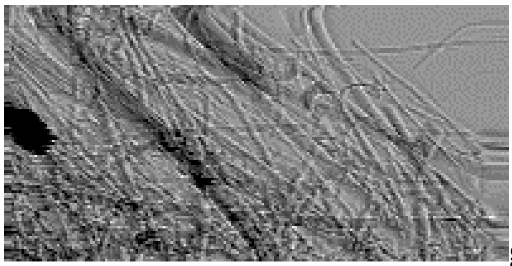


Fig.1: Theoretical modeling of a zone plate pattern for generating a 2 spots beam and the real optical element in tilted view imaged by SEM techniques

As a relevant application on the SXM, X-ray fluorescence (XRF) measurements were accomplished by using 2 spots DOE on SiO_2 fiber air pollution filter. In Fig.2 are compared absorption measurements performed at 4 KeV with a single zone plate (Fig. 2a) with 2 spots DIC measurements (Fig. 2b). The picture shows that even when the absorption contrast is very poor (the sample thickness is estimated to be few microns), the DIC measurements shows many sub-microns details. Moreover, we measured the DIC morphology simultanuosely with the elemental distribution by XRF measurement. In figures 2c and 2d it is shown the Calcium and Potassium distribution. This measurement combined with the size distrubution of the elements is an important information from enviromental point of view because it is correlated to human body desease induced by air pollution.



a)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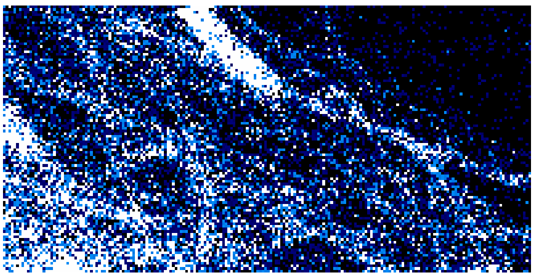
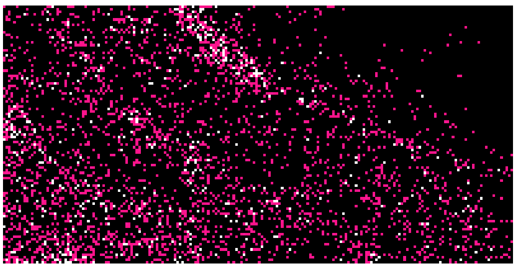
b)



c)



d)

Fig. 2: The tremendous increase in image contrast using novel X-ray diffractive optical elements creating a differential interference contrast mode in demonstrated in imaging SiO_2 fibers of air pollution filters. (a) is a brightfield or absorption image acquired with the ID21 scanning X-ray microscope at 4 keV photon energy and a conventional ZP. (b) is the image in differential interference contrast acquired with the novel 2-spot diffractive optical element. (c) and (d) are XRF maps of Ca respectively K acquired simultaneously.