GISAXS on LOWK

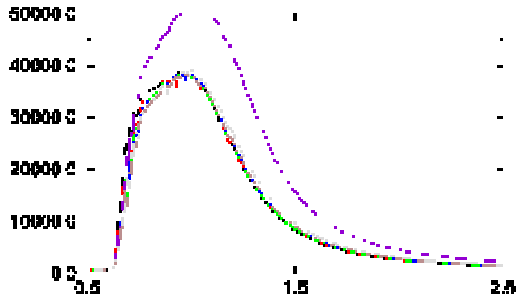
This report will focus on the Lowk-deposited layer obtained by spin coating of a mixture of the SiOC matrix and of a porogen. The porogen is sacrificed by a thermal treatment or by an UV illumination and finally the fraction of pores in the lowk can reach 50%. Nevertheless the layer must also support mechanical stresses and therefore the aim is to obtain nano-scale pores, homogeneous distributed both in sizes and in position.

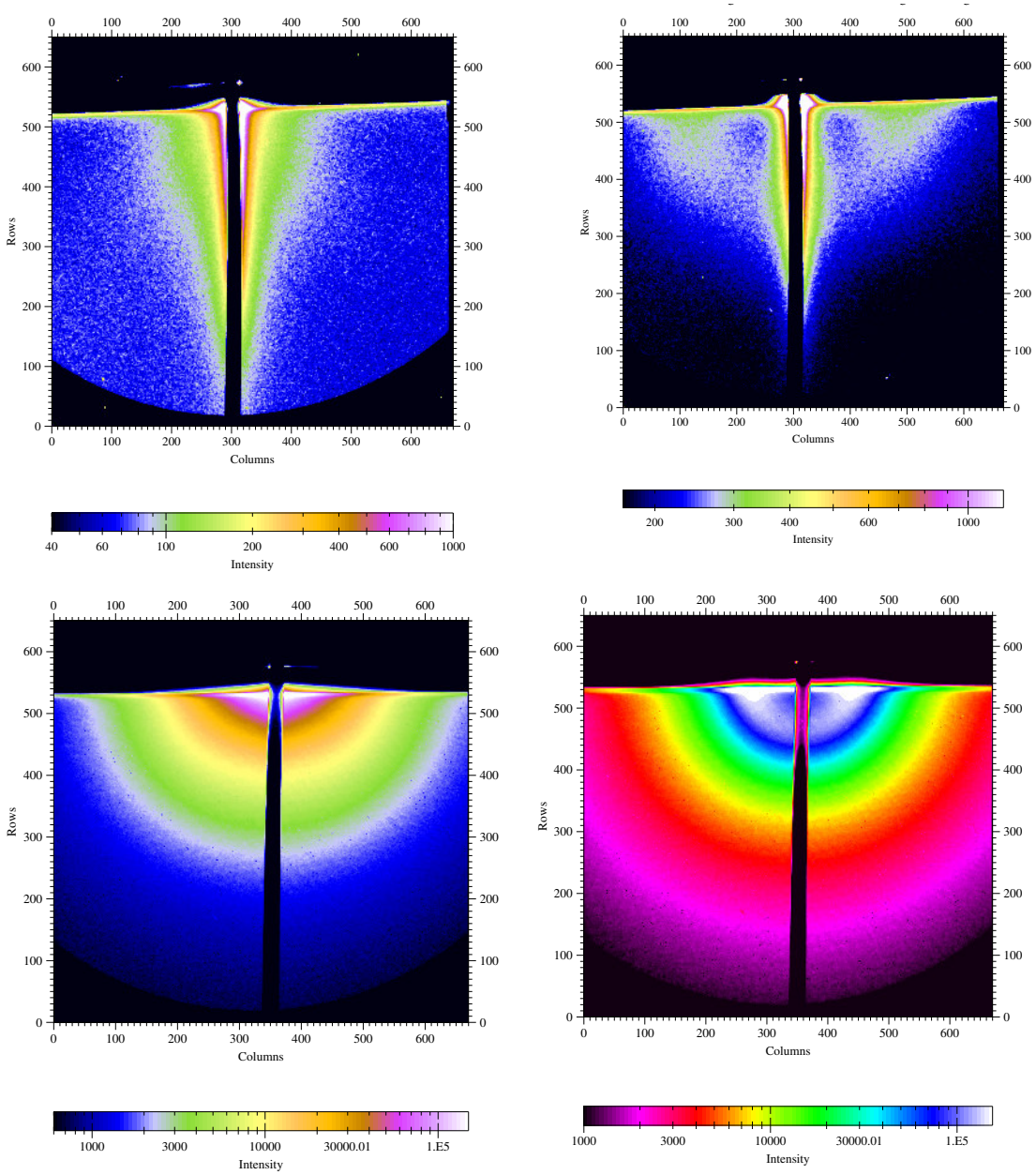
The 2d images of samples are very different.
Let us mention that the distortion due to the refraction is almost negligible beyond the Yoneda reinforcement at the limit of the shadow of the sample. The absorption of the 200nm layer is also negligible since the incidence angle is higher than the critical angle of Si (0.216 degree at 8keV), itself higher than the one of the layer (ranging between 0.14 and 0.18 degree): most of the incident photons are simply absorbed by the 0.75 mm thick Si.

We can qualitatively classify the patterns in four families. (exemple are given on next page from left to right and from up to bottom)
(1) No layer signal superimposed with a roughness signal,
(2) weak anisotropic signal
(3) strong isotropic (or almost isotropic) signal, decaying from the origin.
(4) isotropic signal with a well defined maximum ring.

In the (1) patterns the presence of pores cannot excluded, but, if any, their size should give a signal masked by the sample shadow: they are larger than 10nm in diameter.
The (2) patterns are difficult to interpret: the correlation with a maximum of intensity in the horizontal direction means perhaps that there is in plane correlation of pores, but a superficial structured roughness may give a comparable pattern.
The (3) patterns have been radial averaged: the present a rapid decrease with q; nevertheless, we cannot define a Guinier radius and a fit with a distribution of pores shows that the width of the distribution would be larger than the mean size; the confidence on the model is questionable in that case; nevertheless we can have an other evaluation: since the integral of $I*q^2$ is proportional to the pore volume fraction, we can define a "pore size" which contribution to the volume fraction is the most important. Such an analysis only works for some of the samples. Their diameter is of the order of 4nm.
The (4) patterns indicate a narrow distribution of pores with a rather constant average distance between them. A rather complete analysis has been done as for large volume fraction of precipitates in alloys.

Finally let us mention that the corrected intensity from the monitoring and the incidence angle superimpose quite well, except for α_i=0.2 degree, where the scattering comes both from the incident beam but also from the reflected beam at the interface between the SiOC and the silicon wafer.




Rows
Columns
Intensity
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200 300 400 600 1000
1000 3000 10000 30000.01 1.E5