Characterization of a PECVD-SiC replicated mirror sample

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1. Introduction

The aim of this document is to present topographic and X-Ray Diffraction (XRD) characterizations of a PECVD-SiC replicated mirror. The master was a Si wafer of about 10 cm in diameter. The sample was produced by Galileo Avionica CETEV.

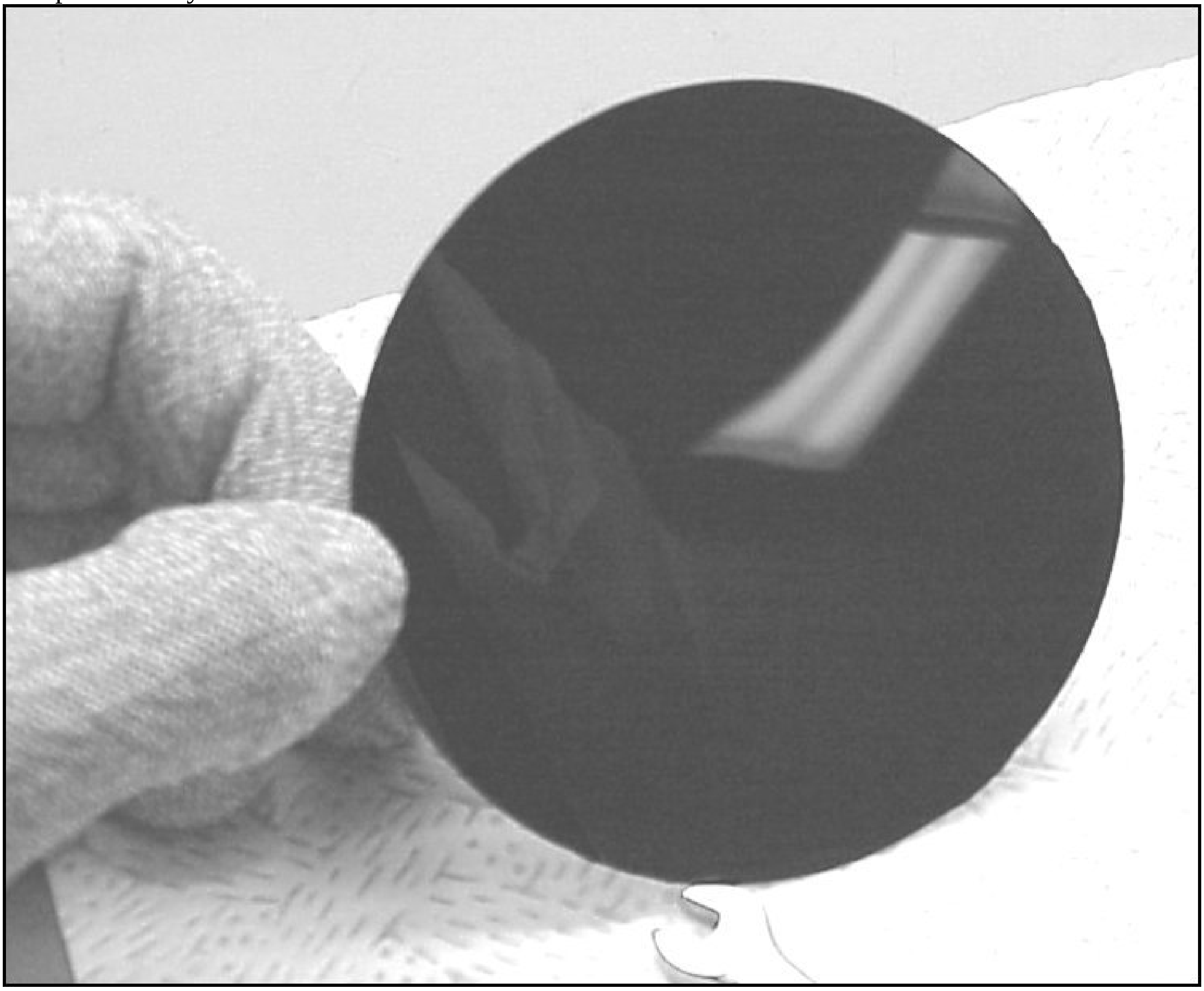

Fig.1: The replicated mirror sample in PECVD-SiC whose characterisation is presented in this document.

2. Topographic mirror characterization

As a first investigation of the reflecting surface we have observed the sample by a phase contrast Nomarski microscope. This kind of analysis is very useful to observe the surface aspect, even if this instrument doesn't allows us to extract quantitative information about the roughness level.

A B C D

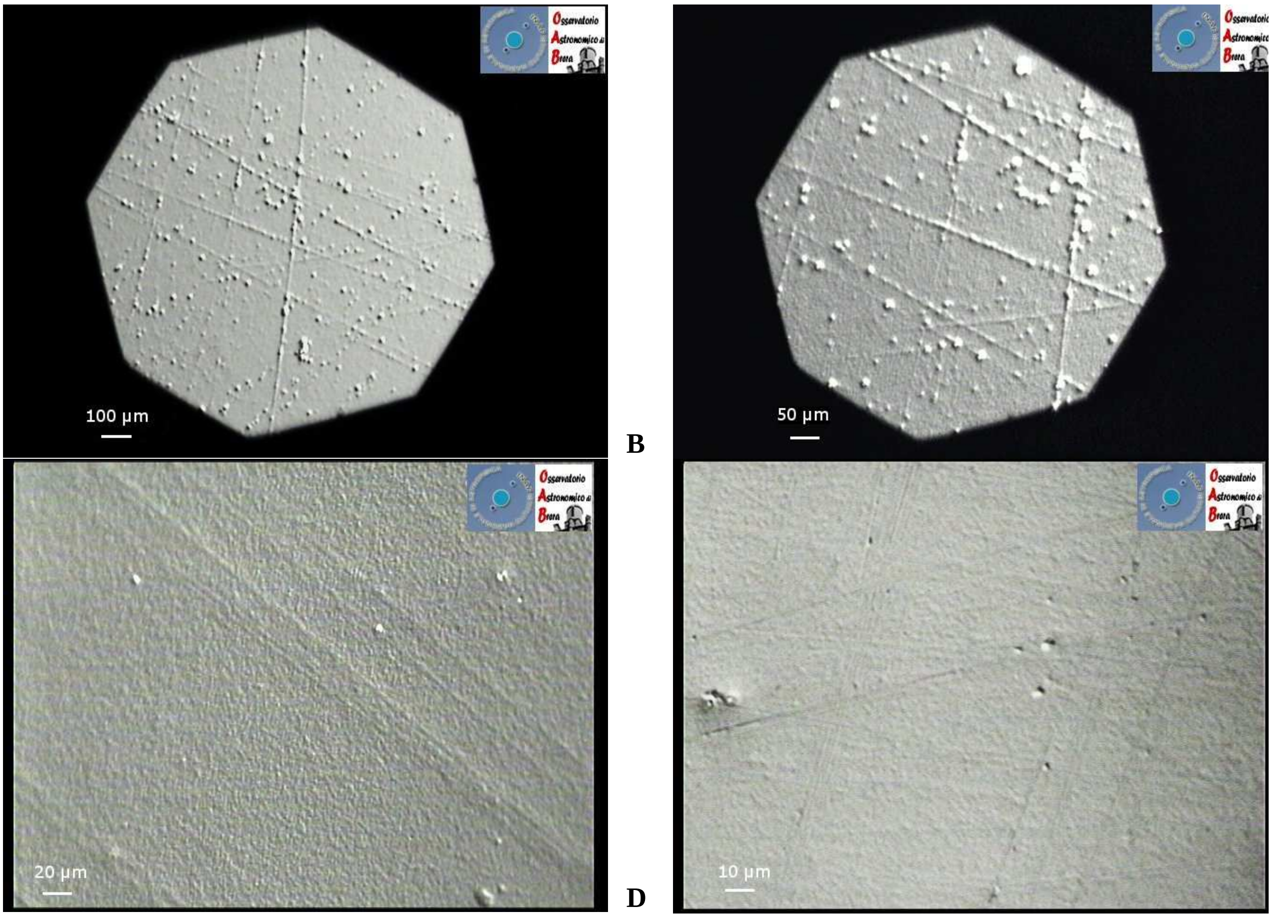

Fig.2: Surface photographs taken with a Nomarski microscope at different zoom magnification. Viewing the surface with a small enhancement (A or B) some scratches and a quite high number bumps/holes are visible, whereas by increasing the zoom it become possible to view the surface microtopography features (D).

By using the optical profilometer WYKO we measured the surface profile. The roughness measurements were carried out with both instrument heads (2,5X and 20X) available at INAF/OAB to cover a large frequencies spectral range. To avoid the inclusion of particular local features and to minimize the statistical error we have repeated the measurement for some profiles over the whole surface. The PSDs has been evaluated as the average of 5 profiles.

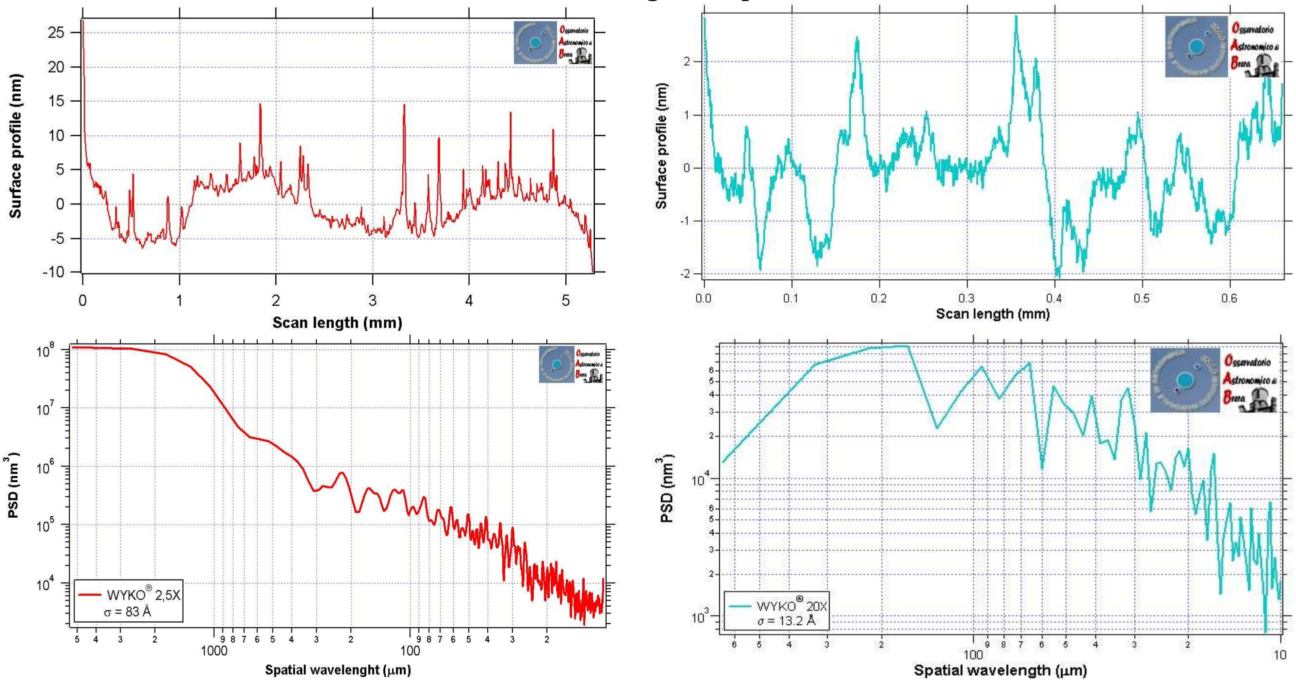

Fig.3: (top) Two typical surface profiles obtained by the optical profilometer WYKO with 2,5X (left) and 20X (right) magnification. The scan length of the 2,5X is comparable (a factor 5 bigger) to the diameter of the Nomarski photograph showed in A.
(bottom) The Power Spectral Densities (PSD) of the profiles on the top. The RMS microroughness level measured for this surface is of about 80 Å in the spectral range [5000÷10] µm and 13 Å for [660÷10] µm.

Another measurement of the surface microroughness level was performed using an Atomic Force Microscope (AFM) to probe the high spatial frequencies domain of the surface spectrum. The figure 4 shows some scans in 2D and 3D visualisation, the PSDs obtained are plotted in figure 5. As a confirmation of the measured σ_{RMS} in the spectral range [100÷1] μm we have made use of a well known TMa Technologies μScan scatterometer resulting in a good agreement with the AFM scans (σ = 24 Å)

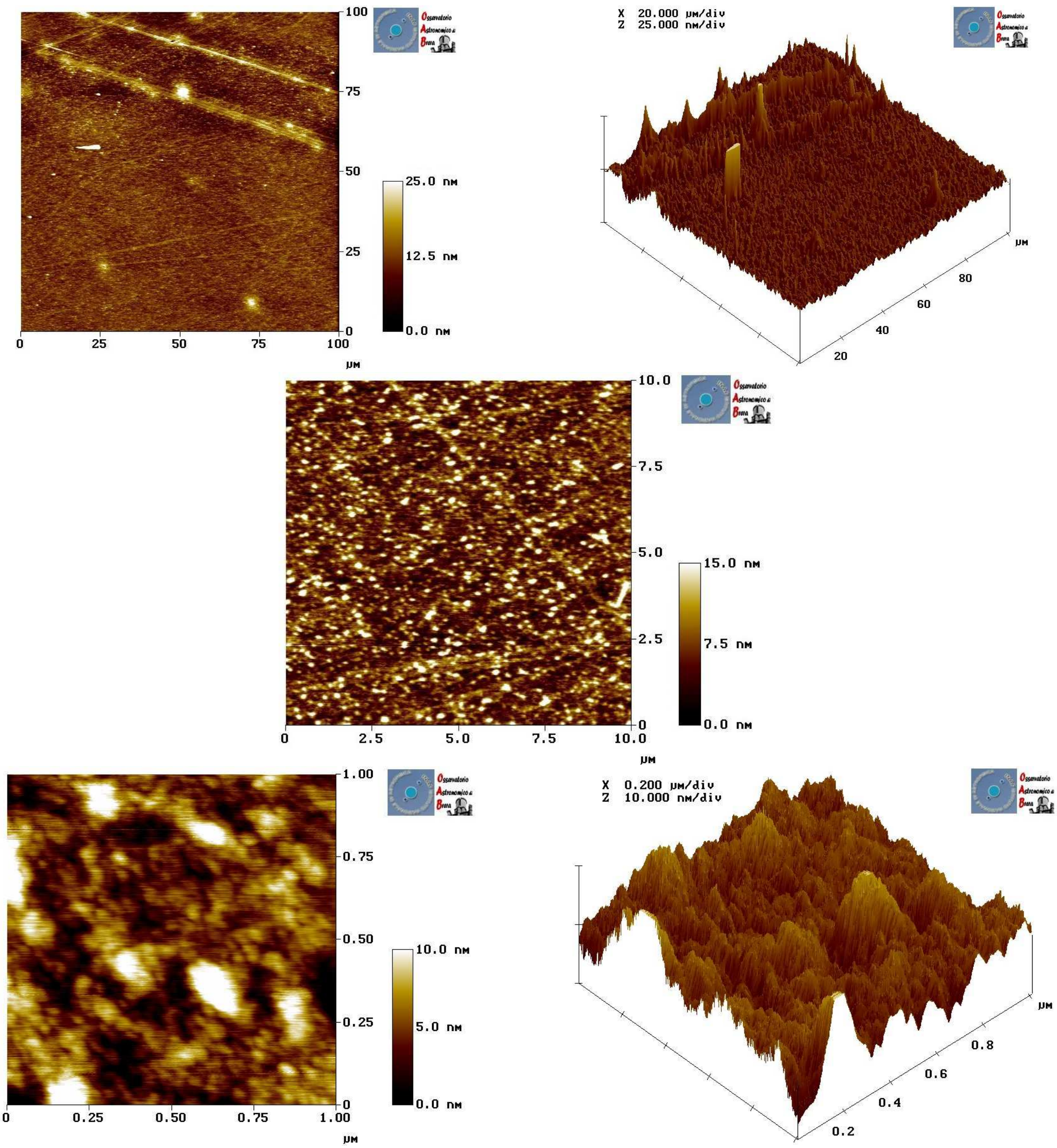

Fig. 4: Bi- and tri- dimensional images of some AFM scans of the mirror surface taken with the Digital Instrument AFM available at INAF/OAB. The scans were performed on 100x100 μm^2, 10x10 μm^2 and 1x1 μm^2 surface area.

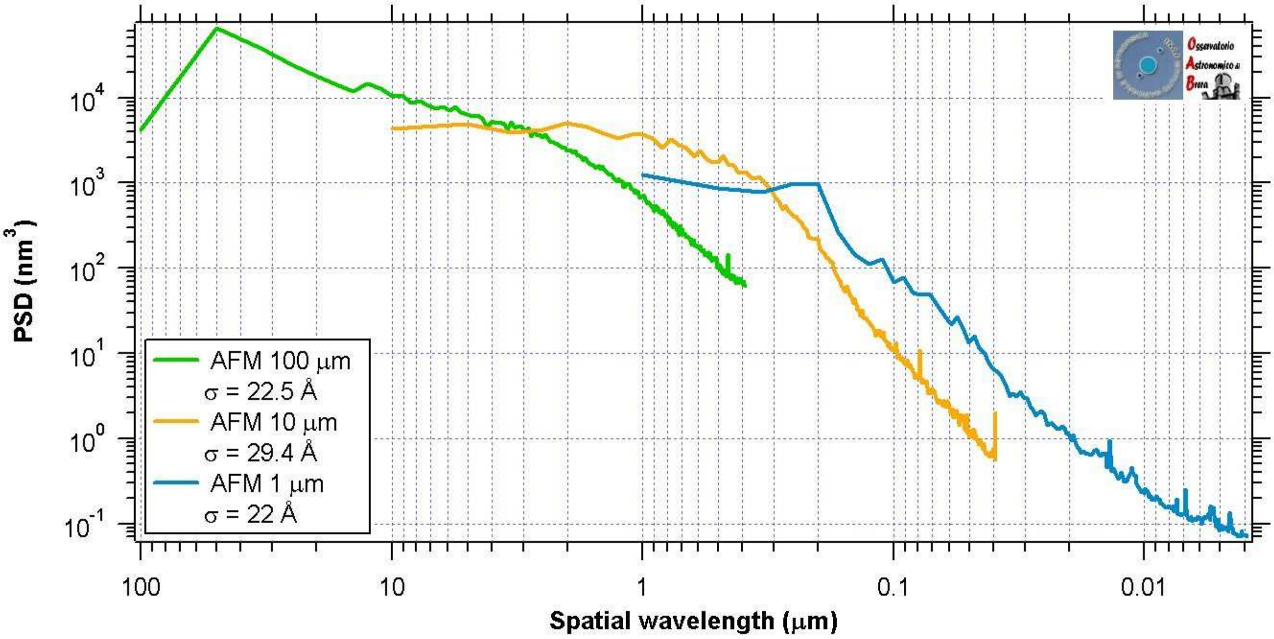

Fig. 5: Trend of the PSDs derived from the AFM of the surface scans of fig. 4. The measured RMS microroughness level is also showed: $\sigma_{100\mu m}$ = 22.5 Å, $\sigma_{10\mu m}$ = 29.4 Å, $\sigma_{1\mu m}$ = 22 Å. As a cross-check for the σ_{RMS} value in the range [100÷1] µm, the surface quality was measured also with a TMa Technologies µScan scatterometer. The roughness value was about 24 Å in good agreement with AFM.

In figure 6 and 7 we show the PSD trend in the wide spatial wavelength range [5000÷0.004] µm and the microroughness values computed in the spectral range of sensitivity of each instrument (WYKO 2,5X and 20X, AFM, scatterometer).

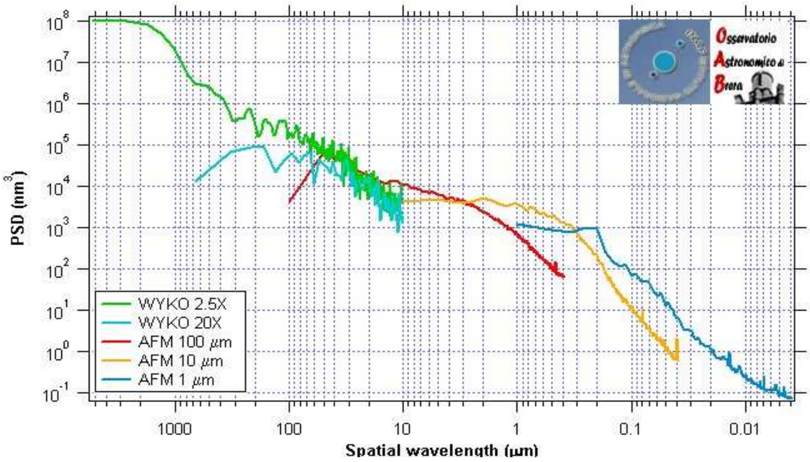

Fig. 6: Global PSD trend from 0.004 µm up to 5000 µm obtained measuring the mirror sample with the WYKO and AFM instrument available at INAF/OAB. The PSDs show a good agreement in the overlapping spectral ranges also if taken with different instruments.

Instrument	***Spatial wavelen. range [µm]***	***σ_{RMS} [Å]***
WYKO 2,5X	*[5000÷10]*	*83*
WYKO 20X	*[660÷10]*	*13.2*
Scatterometer	*[100÷1]*	*24*
AFM	*[100÷0.4]*	*22.5*
AFM	*[10÷0.04]*	*29.4*
AFM	*[1÷0.004]*	*22*

Tab.1: Overview of the microroughness level for the PECVD-SiC sample under test.

3. X-Ray Diffraction mirror characterization

The reflectivity tests have been done by a Bede D1 diffractometer with a W anode X-ray tube. From the bremsstrahlung continuum has been isolated the W-$L_{\alpha1}$ line at 8.39 keV to probe the crystalline microstructure with a monochromatic beam. The eventual presence of crystallites would cause a sharp diffraction peaks when the X-rays incide on the sample with different angles. The graph in figure 7 shows a large angular scan taken in [1÷40] deg range. No diffraction peaks were detected. This can be considered a hint in favour of an amorphous structure of the SiC material.

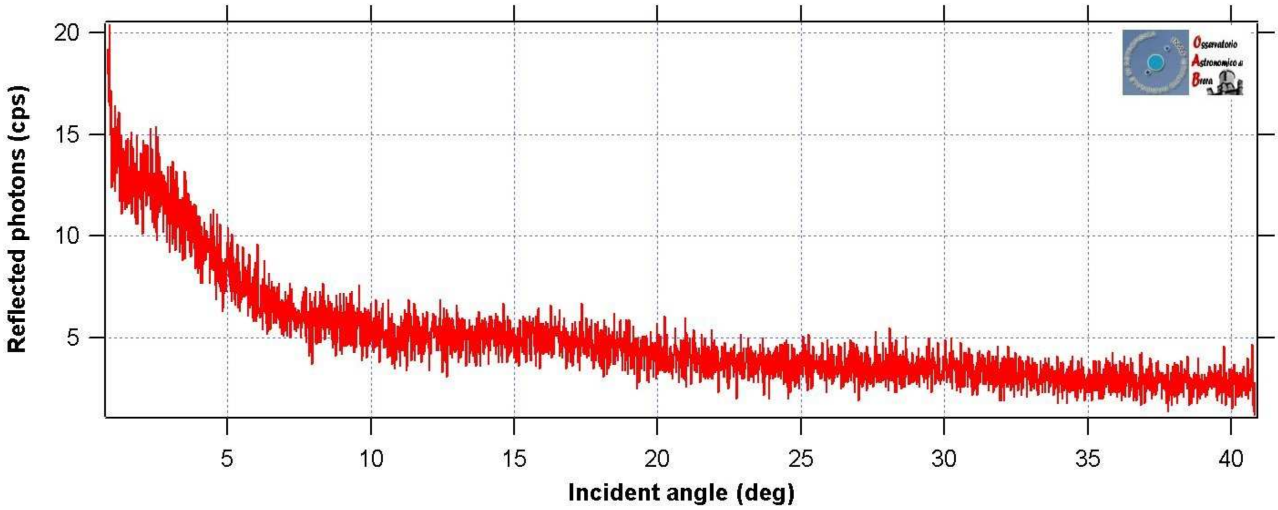

Fig. 7: Photos reflected by the mirror sample taken with a large angular scan. The curve don't shows any kind of peak, neither for big angles of incident. This means that are absent, or in a very small number, any kind of crystal structures. This can be considered a proof of an amorphous growth of the SiC.