



LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

LIGO Laboratory / LIGO Scientific Collaboration

LIGO-T1600104-v4

LIGO

Date: 6/6/2016

EUV reflectivity measurements of black coatings at ALS, LBNL

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EUV reflectivity of six coatings samples has been measured within the energy range from 40 to 100 eV using ALS at LBNL. Figure 1 shows the vacuum chamber with target holder in the center and detection system on the right. The chamber has been pumped down to lower 10^{-6} torr range within half an hour.

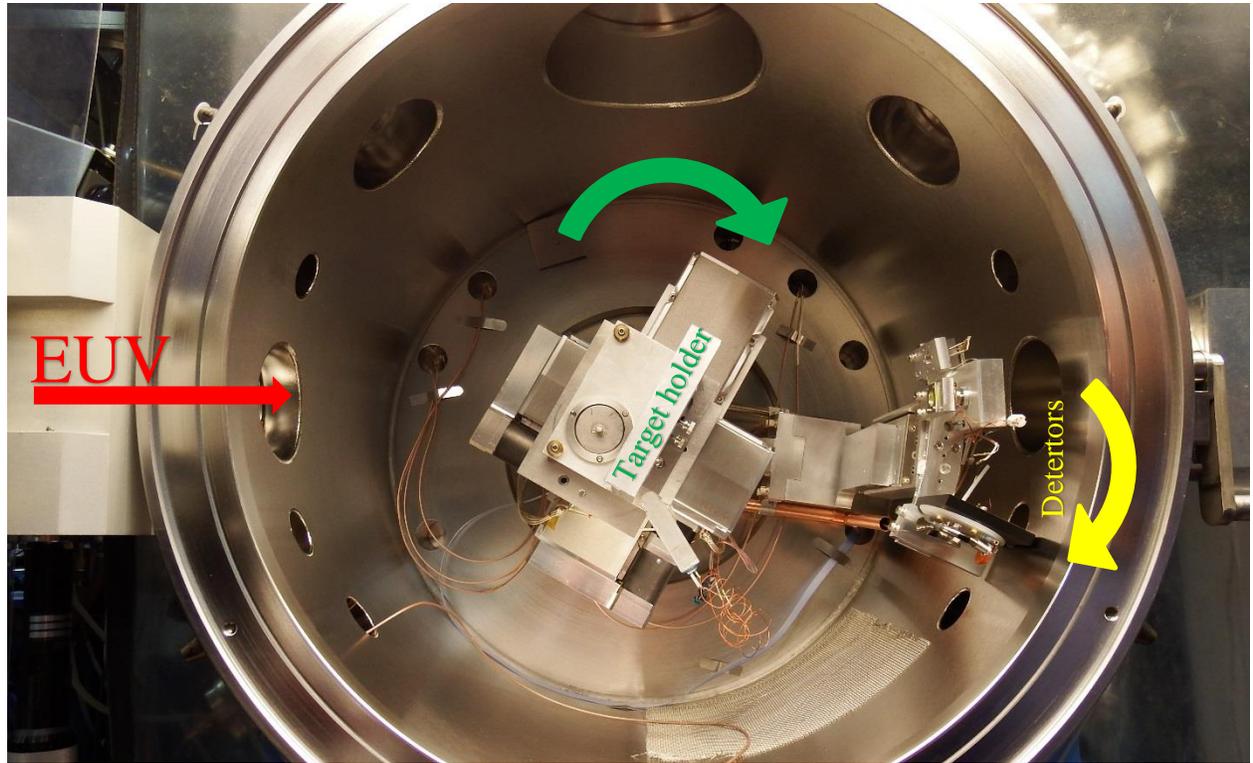


Figure 1. Vacuum chamber: two goniometers rotate and translate the targets holder and detectors arm independently.



Figure 2. Target holder close up with the coatings samples and a gold mirror.

The six samples mounted on a holder next to a EUV mirror are shown in figure 2.

- 1) Black Nickel on 14 Ga SS substrate
- 2) Black Nickel on 14 Ga bead blasted SS substrate
- 3) Undisclosed black coating on 10 Ga Al substrate
- 4) Undisclosed black coating on 20 Ga SS substrate
- 5) Chromium oxide on 14 Ga SS substrate
- 6) Structural black coating on 20 Ga substrate

Additionally a stainless steel plate was mounted on the same target holder.

An Au x-ray mirror was installed next to the samples as a reference sample with known reflectivity versus energy. Figure 3 shows absolute reflectance of the gold mirror as function of the photon energy.

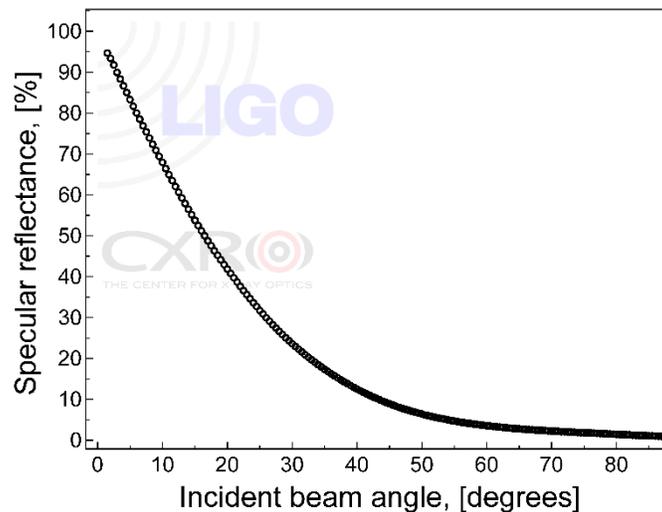


Figure 3. Absolute reflectivity of the Au mirror as a function of the incident photons angle

The detection system consist of a photodiode and a channeltron that can be used independently. An absolute reflectivity can be measured only with the photodiode but the count rate of the reflected EUV from the black coatings was at the level of the dark count at 60 degrees incident angle. Therefore a relative EUV reflectivity was measured using the channeltron and normalized by the factor estimated from the reflectivity of the gold mirror measured with each detector.

The photon beam supplied by the ALS had a waist of 300 micron and intensity in the range of 0.1 – 1 μ W. The incident energy was tuned using a grating monochromator. Three type of measurement have been made on six coatings samples and on a bare stainless steel plate:

- 1) Specular reflection beam incident angle scan from 0 to 90 degrees relatively to the samples at 40 and 80 eV
- 2) Specular reflection energy scans at 60 degrees beam incident angle 3 ranges: from 35 to 50 eV (0.2 eV step), from 49 to 71 eV (0.5 eV step) and from 69 to 99 eV (0.25 eV)
- 3) Detector observation angle scans from 60 to 140 degrees relatively to the samples at 60 degrees beam incident angle. Measurements at 40, 50, 60, 70, 80, 90 and 99 eV.

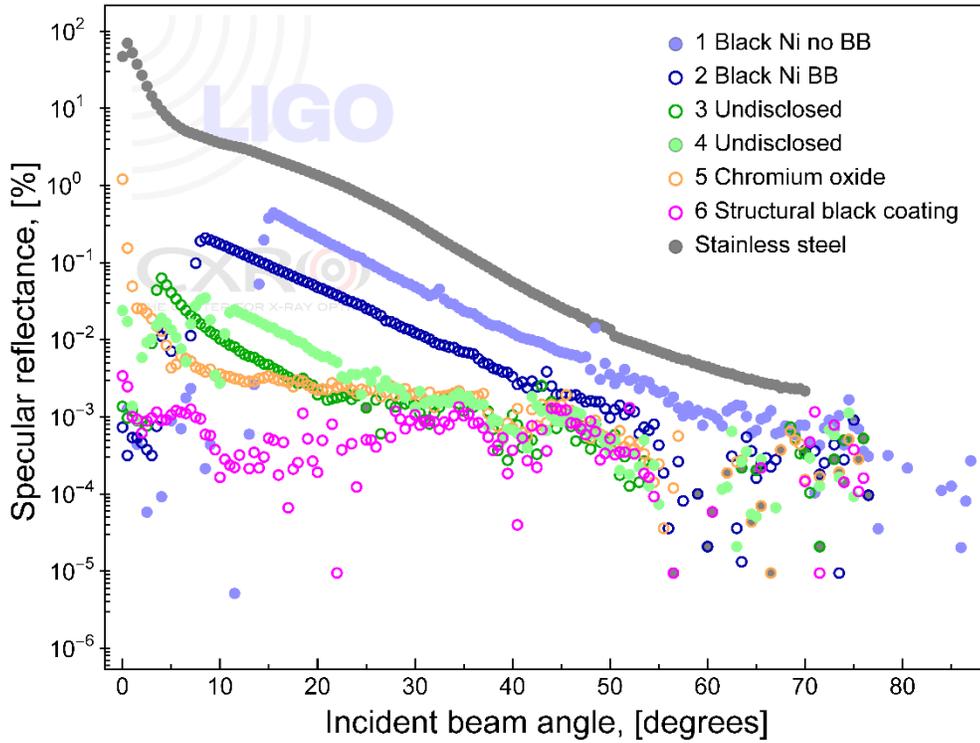


Figure 4. Specular reflectance measured at 40 eV as a function of the beam incident angle relatively to the samples

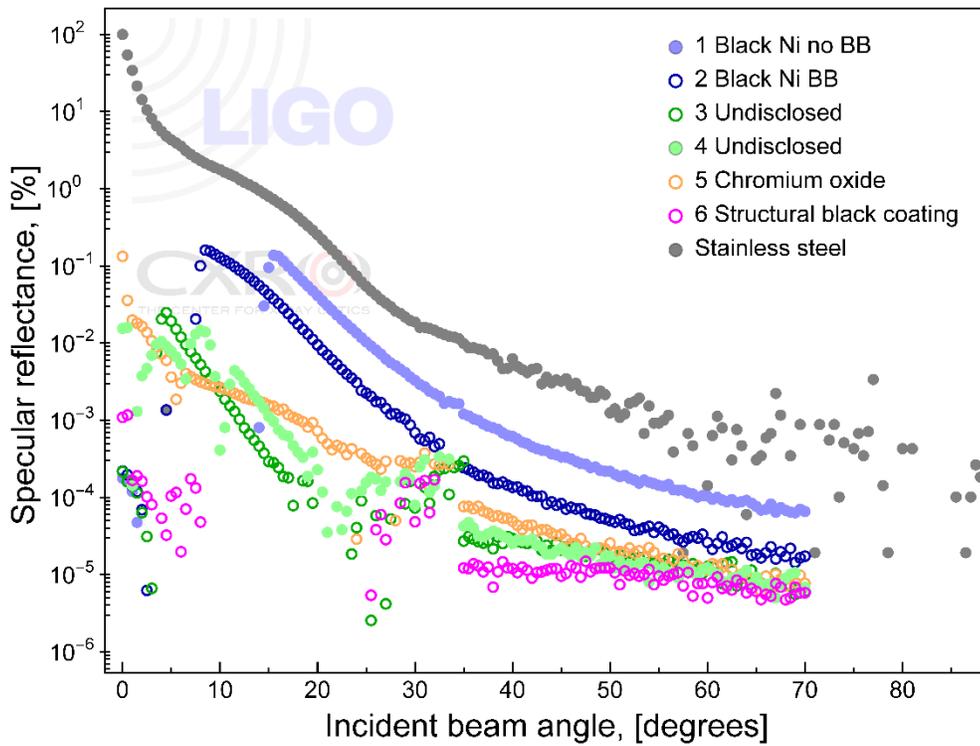


Figure 5. Specular reflectance measured at 80 eV as a function of the beam incident angle relatively to the samples

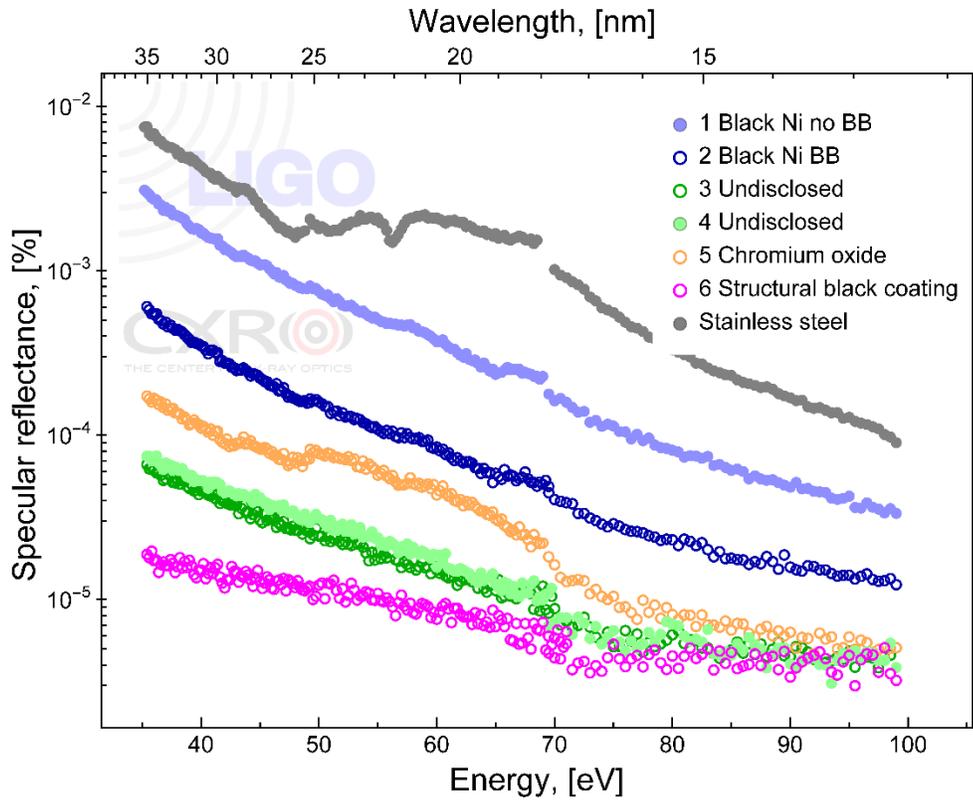


Figure 6. Specular reflectance measured at 60 degrees as a function of the photons energy

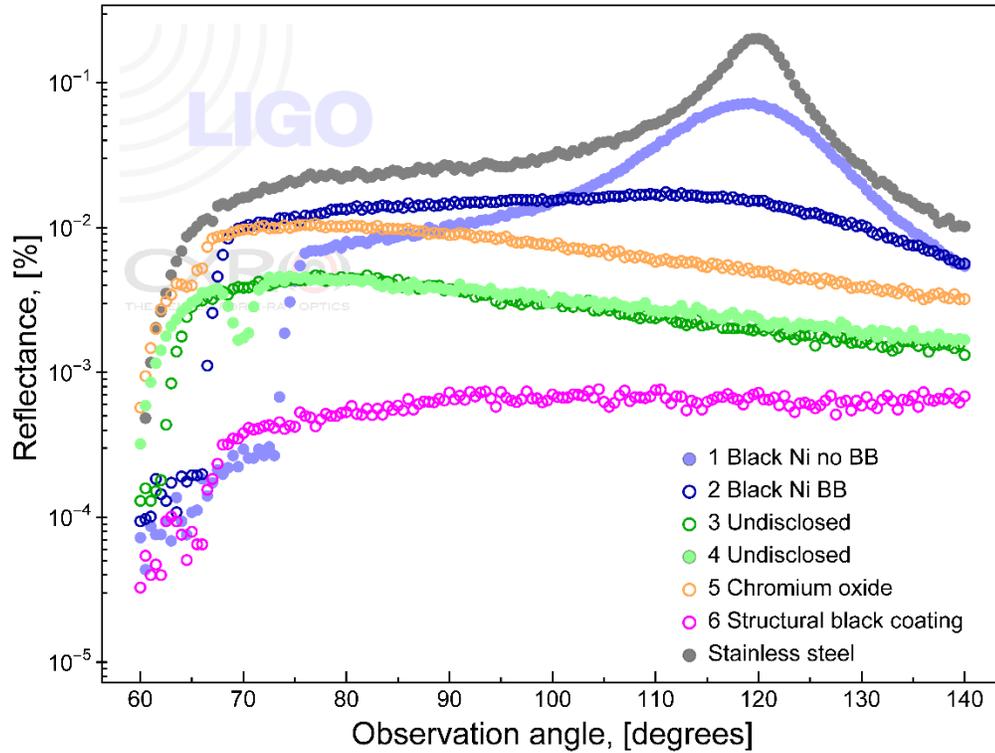


Figure 7. Reflectance measured at 40 eV under 60 degrees incident angle as a function of the detector observation angle

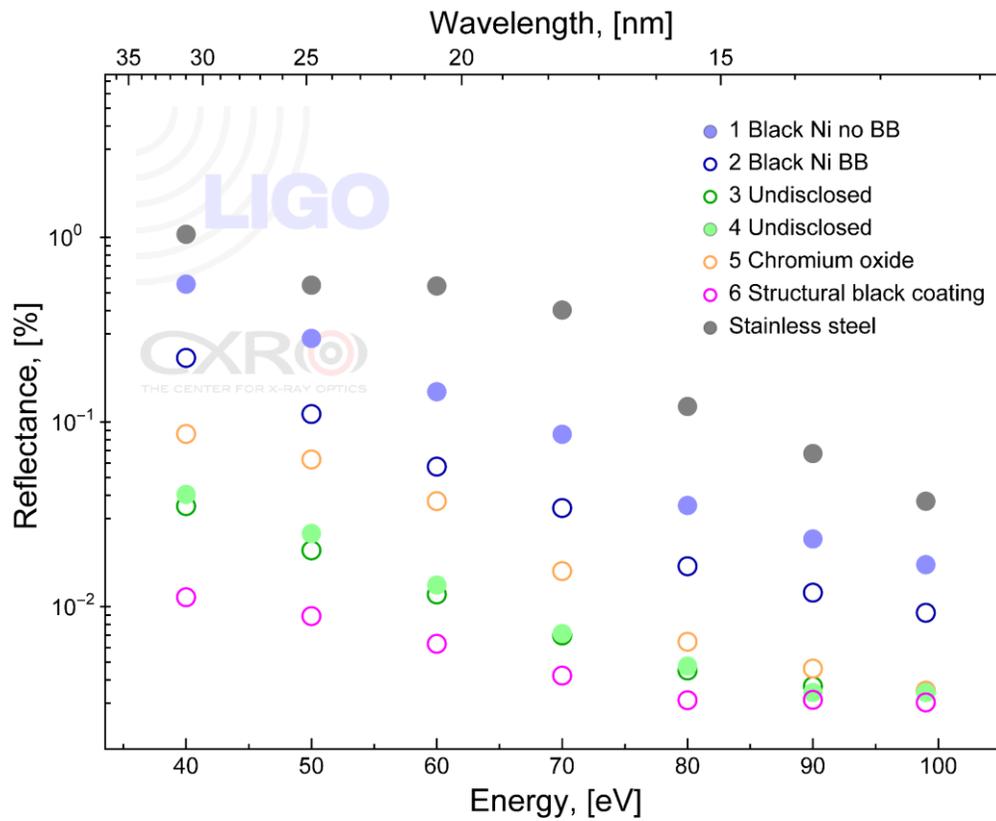


Figure 8. Total reflectance over 2π estimated using the measurements under different detector observation angles at 40, 50, 60, 80, 90 and 99 eV photon energy at 60 degrees incident photons angle