

## Reminisce - Refurbishment of Mirrors to Increase Sustainability at Light Sources Introduction of a European collaboration project

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The degradation and Carbon contamination of X-ray optics is a well-known problem in X-ray beamlines that has been detrimental to beamline performance for several decades. This is particularly problematic, as such optics are usually highly specialized and coated with various materials. Consequences of such contamination include loss of flux, distortion of the wavefront, and reduction in focusing power and resolution.

With new and upgraded light sources having much higher photon intensity and repetition rates that are built in several places in the world, more rapid accumulation of contamination and damage will occur. This currently places X-ray optics amongst the most expensive consumables at Synchrotrons and XFELs, in terms of cost and beamline downtime. The cost per optic is typically tens of thousands of Euro and can exceed 100k Euro. With that and production times up to more than 1 year, the option of refurbishing and cleaning X-ray mirrors to overcome this problem is substantial.

This has been discussed within the community for a long time and on several occasions in metrology and X-ray optics meetings, emphasizing the need to find suitable methods. Numerous trials, independently conducted in recent years by European experts in X-ray optics, have been made. Various treatments to remove organic residues from the samples have been tried, including: adding a partial pressure of oxygen into the vacuum vessel; illumination with UV light or plasma treatment; chemical stripping of contaminated optical coatings; or repolishing the substrate. Research has progressed slowly, on an ad-hoc basis, with minimal funding. Due to a lack of time and samples, extending those single tests to systematic studies is difficult. First experiences showed that cleaning techniques that work for one mirror aren't effective for a nearby optic, pointing to hidden complexities, such as temperature, X-ray flux and wavelength spectra, and proximity to nearby sources of carbon (such as motors or cables). These issues clearly show that coordinated action is now required.

For that purpose, a workshop dedicated to "Cleaning and Refurbishment of Optics" was held at Trieste in February 2025. It was attended by many experts representing most synchrotron and XFEL labs in Europe and the collaboration project REMINISCE (Refurbishment of Mirrors to Increase Sustainability at Light Sources) has been. In a large and coordinated group effort of European experts from various relevant scientific disciplines, REMINISCE aims to:

- Determine essential experimental variables for dynamic growth and in- and ex-situ removal of carbon contamination on X-ray optics.
- Develop reliable methods to clean and refurbish X-ray optics to a pristine condition for optimal beamline performance, underpinned by surface science and optical metrology feedback.
- Develop processes compatible with full-size, beamline X-ray optics (e.g up to one metre in length).
- Share Reproducible technical recipes and community-wide recommendations

The project and first results of preliminary studies will be presented here.