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PHOTON STIMULATED DESORPTION BEAMLINE AT NSLS- II

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Abstract

Understanding synchrotron induced gas desorption plays an important role in predicting vacuum behaviour of accelerators. Investigations of new materials and coatings require careful study of their desorption yield for potential use in upgrading NSLS-II as well as other accelerator facilities. A beamline at NSLS-II, dedicated to the study of novel and proposed vacuum materials has been constructed and commissioned to advance further research into desorption behaviour. The PSD of stainless steel, OFHC copper and NEG coated copper, some of which for use in the future Electron-Ion Collider at BNL, have been measured and will be presented. These newly established desorption rates will be used as inputs to advanced modelling tools such as MolFlow+ and SynRad+ [1] for accurate predictions of vacuum behaviour and design optimization. The existing layout and future plans for the beamline will be presented.

EXPERIMETNAL

The method used to measure the desorption will be similar in the method used at NSLS and other synchrotrons around the world. A significant body of work exists on desorption studies of various materials, coatings and surface conditions [2-17]. However, new materials, geometry and surface condition, and optimization of cleaning methods should be evaluated and measured to gain confidence in design choices prior to selection.

The beamline is located at port 14-BM at NSLSII and will be supplied with light from a 3-pole wiggler and dipole bending magnet (shown in Figs. 1 and 2).

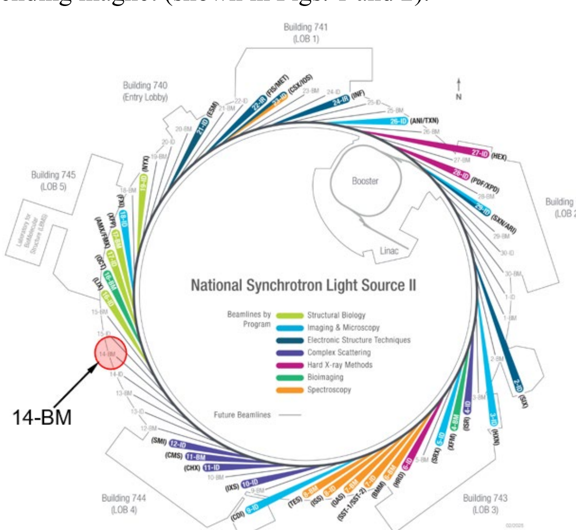
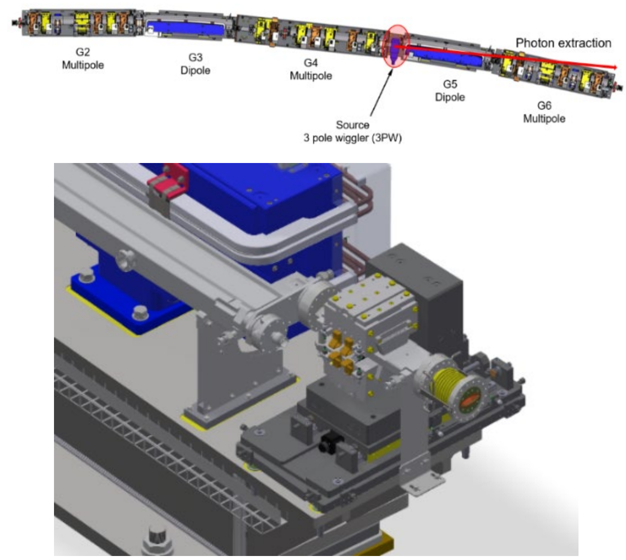


Figure 1: Location of beamline at NSLSII.



(a)

(b)

Figure 2: (a) Three pole wiggler (3PW) upstream of bending magnet dipole (BM), (b) Picture of beamline endstation with NEG coated copper prototype vacuum chamber for the EIC electron storage ring.

Together, the 3PW and BM produce the characteristic light reaching the sample (Fig. 3).

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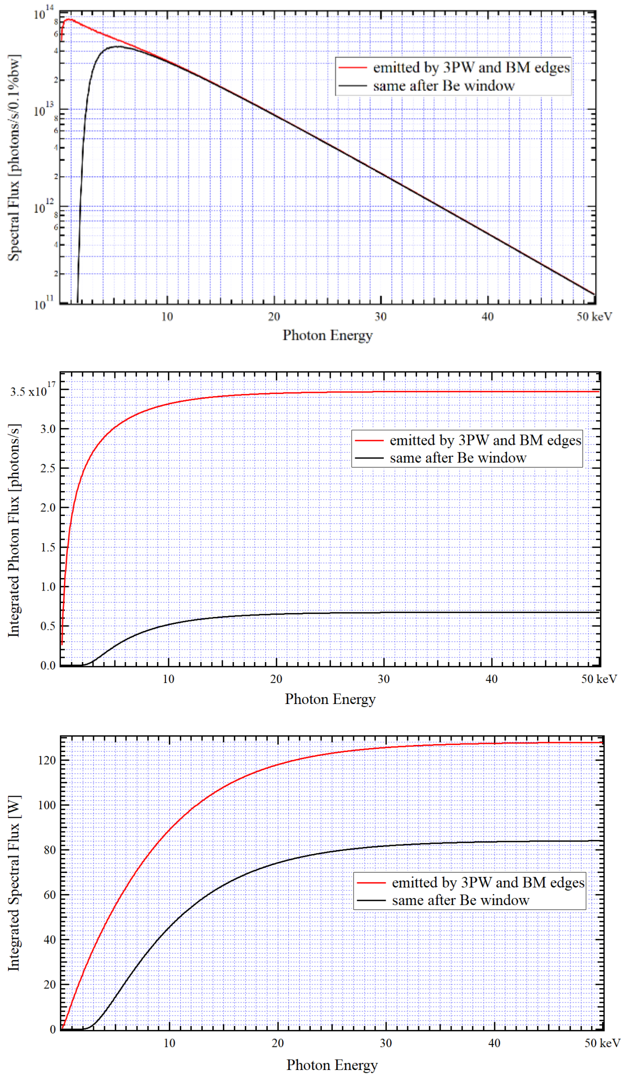

Figure 3: Characteristic light, spectral flux, integrated flux and power reaching the sample, shown with and without beryllium window.

Light from the exit pipe is delivered to the endstation through a fixed aperture mask and beryllium window. Downstream from that are a set of X-Y slits to control the spot size based on the sample tube dimensions. From this section, light passes through a drift tube for space considerations in the tunnel and arrives at the endstation (Fig. 4).

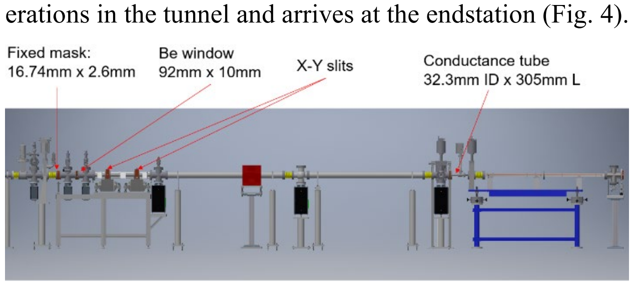

Figure 4: Beamline general arrangement.

The endstation (Fig. 5) consists of a low-pressure region upstream of the sample consisting of an ion pump/TSP and a low base pressure turbo. This region is separated from the downstream chamber by an orifice of known conductance. Pressure is measured on both sides of the orifice and desorbed gas quantified with an RGA. A gate isolates the sample chamber so chambers can be vented or replaced easily. The sample chamber is surveyed in a position so light strikes only the sample surface at a known angle of incidence. The maximum available power hitting the sample tube is 80w, so simple water cooling to stabilize the chamber temperature is used. Knowing the flux, and integrated dose, desorption curves are generated.

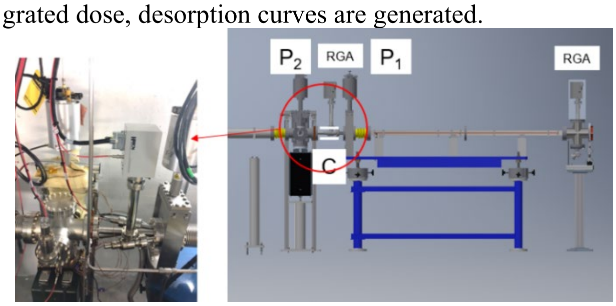

Figure 5: Endstation configuration.

At 400mA of beam operation, the beamline can deliver 5x10^{16} photons/s. This results in ~e^{20} ph in ~30min and e^{23} ph in ~23 days.

RESULTS

Initial testing was done on 304L stainless steel tubing, cleaned using the NSLSII cleaning facility and then baked prior to installation in the endstation. The results compared favorably to prior work at NSLS (Fig. 6) [18].

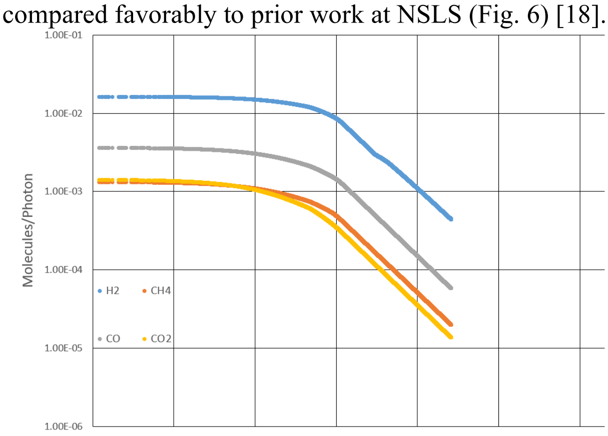

Figure 6: Results of 304L.

The next sample tested was C101 copper tubing. The tubing selected was a potential material choice of the RCS (Rapid-Cycling Synchrotron) injector for the EIC (Electron-Ion Collider). The sample was subjected to the NSLSII cleaning process prior to installation and subject to a mild pre-bake. The results show slightly higher methane and CO when compared to the measured copper plated tubes for the SSC [19]. This is likely an indication of less than adequate cleaning (Fig. 7).

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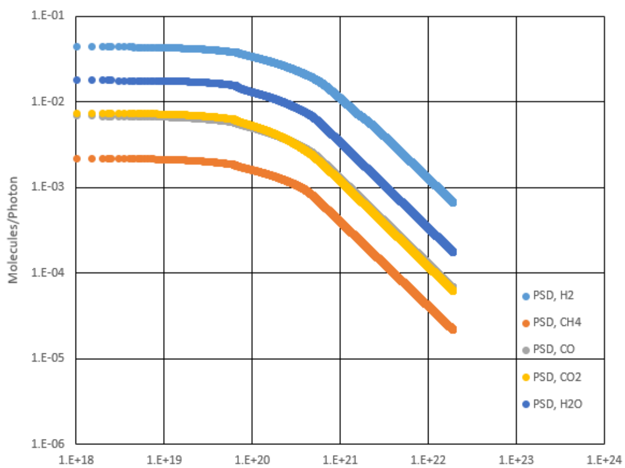

Figure 7: Results of C101 Cu.

The most recent test was conducted on the NEG coating copper beamtube of the EIC electron storage ring (Fig. 8). This prototype yielded very low desorption rates and compared favourably to work done at KEK on CERN provided NEG samples [20].

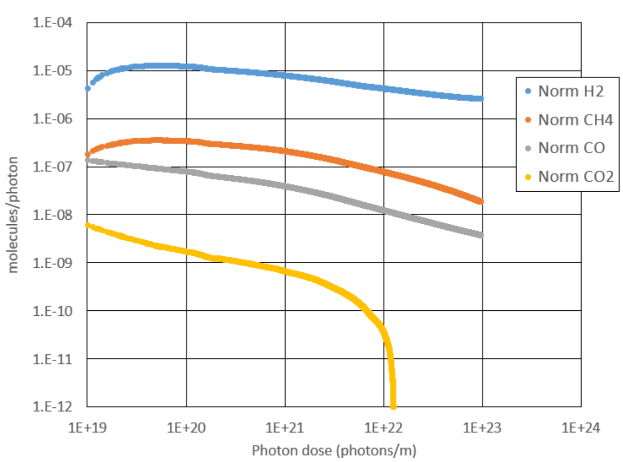

Figure 8: Results of NEG coated Cu.

The desorption curves at very low dose rates are lower than expected. This is a result of the sample chambers being under vacuum pumping for some period prior to first light, a result of needing to establish vacuum on the sample for extended duration prior to measurement due to limited tunnel access.

A pickup probe to measure forward scattered photoelectrons was recently installed and successfully tested. Forward scattered photoelectrons will be measured for future samples and components. This beamline will be used to optimise geometry to minimize photoelectron scatter of newly designed absorbers for the future NSLSIIU upgrade.

CONCLUSION

A beamline for the study of desorption was successfully commissioned at NSLSII. Measurements of known materials compare favourably to past work. The beamline has successfully evaluated materials and geometry for both the RCS and ESR rings for EIC and is available for collaborations on other projects. The beamline is being upgraded to study both in-house coated NEG chambers and also advance absorber designs for NSLSIIU to minimize photoelectron production.

ACKNOWLEDGMENTS

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