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Plasma cleaning of hydrocarbon and carbon contaminated surfaces of accelerator components

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To achieve the vacuum quality required for the operation of particle accelerators, the surface of the vacuum vessels must be clean and free of hydrocarbons. This is usually done by wet chemistry processes, e.g. degreasing chemical baths that, in case of radioactive vessels, must be disposed accordingly. An alternative way to perform the removal of hydrocarbons exploits the oxygen plasma produced by a downstream RF plasma source. This technique offers the possibility of operating in-situ, which is an advantageous option in the case of voluminous and/or fragile components and a more sustainable alternative to large volume disposable baths. In this work, we test a commercial plasma source in a dedicated vacuum system equipped with a residual gas analyser (RGA) and quartz crystal microbalances (QCMs). The evolution of the hydrocarbon RGA peaks and the removal rates of amorphous carbon (a-C) thin films deposited on the QCMs to mimic contamination are studied. The plasma cleaning efficiency is evaluated as a function of various operational parameters and for chambers of different geometries and volumes. The studies are complemented by finite element simulations and by X-ray photoelectron spectroscopy (XPS) surface analysis. We present the results of the plasma cleaning process applied to the real case of a hydrocarbons-contaminated large vacuum vessel. The evaluation of the vessel cleanliness, based on CERN's outgassing acceptance criteria, is compared to the simulations results.

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Footnotes

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