Electron beam generated hydrogen plasma for material testing and cleaning.

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Inside extreme ultraviolet (EUV) lithography machines a hydrogen plasma is generated due to ionization of the background gas with EUV photons. The interaction of scanner components with hydrogen plasma is tested in laboratory setups, where the properties of EUV-generated plasma are mimicked. Here we present a novel experimental setup at TNO, where a low temperature hydrogen plasma is generated by means of electron impact ionization using a high current, high pressure electron beam (e-beam) gun. Retarded field energy analyzer measurements showed that the produced ion flux and the ion energy are comparable to the scanner conditions. Additionally, compared to electron cyclotron resonance plasma sources, that are typically used in off-line setups, e-beam generated plasma shows less contaminations due to lack of active elements like antennas in the exposure chamber. Finally, in experiments with carbon coated quartz plates we show that the measured carbon cleaning rates are similar to one obtained with hydrogen radical generators but unlike the latter the resulting heat load towards the cleaning surface can be even 2 orders of magnitude lower. Hence, the e-beam generated plasma could also be implemented in the EUV machines for cleaning carbon contaminations from scanner elements like sensors on the wafer stage.