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Negative-ion surface production in hydrogen low-pressure plasmas

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Negative-ions (NI) may play an important role on discharge kinetics in low-pressure low-temperature plasmas, especially when using electronegative gases. NI are usually formed by dissociative electron attachment on molecules, and trapped inside the plasma volume due to the positive potential difference between plasma and surfaces. In certain circumstances, negative-ions are also formed on surfaces upon impact of neutral particles and capture of an electron to the material, or impact of positive ions (PI) and capture of two electrons by the incident particle. These negative-ions are then accelerated back towards the plasma by the sheath and may deposit some energy in the plasma volume. Low work function materials in interaction with plasmas are efficient for NI surface production due to the low energy required to extract an electron from the solid. However, other electronic property of materials, such as the presence of a band-gap or a negative electron affinity, may play an important role in electron capture as demonstrated in beam experiments. In this contribution we quantify and study hydrogen negative-ion surface production on various materials with a strong emphasis on carbon surfaces.
Samples of different kinds are installed on a sample holder in the diffusion chamber of a low-pressure capacitively or inductively coupled plasma, facing whether a mass spectrometer (MS) or a magnetised retarding field energy analyser (MRFEA). The sample is negatively DC biased and NI formed upon PI impact are accelerated towards the plasma. Considering the low pressure used in this study, they cross the plasma without any collision and are collected by the MS which provides a mass and energy analysis, or by the MRFEA which gives the NI current. A pulsed DC biased method has been developed to study NI surface production on insulating materials.
Details on experimental methods and modelling will be given. Basic production mechanisms will be detailed. It will be shown that electronic properties of materials, and not only its work function, can play a role on surface ionization efficiency in plasma.

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