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Ion energy distributions in bipolar pulsed-DC discharges measured at the biased electrode

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The ion current and ion energy distribution (IED) corresponding to discharges in argon or methane were measured in time-averaged mode with a compact retarding field energy analyzer (RFEA). The RFEA was placed on a biased electrode at room temperature, which was powered by either radiofrequency (13.56 MHz) or asymmetric bipolar pulsed-DC (250 kHz) signals. The shape of the resulting IED showed the relevant populations of ions bombarding the cathode at discharge parameters typical in material processing technology: working pressures ranging from 1 to 10 Pa and cathode bias voltages between 100 and 200 V. High-energy peaks in the IED were detected at low pressures, whereas low-energy populations became progressively dominant at higher pressures. This effect is attributed to the transition from collisionless to collisional regimes of the cathode sheath as the pressure increases. On the other hand, pulsed-DC plasmas showed broader IED than RF discharges. This fact is connected to the different working frequencies and the intense peak voltages (up to 450 V) driven by the pulsed power supply. This work raises our understanding in plasma processes at the cathode level, which are of crucial importance for the growth and processing of materials requiring controlled ion bombardment. Examples of industrial applications with these requirements are plasma cleaning, ion etching processes during fabrication of microelectronic devices and plasma-enhanced chemical vapour deposition of hard coatings (DLC, carbides and nitrides).

Keywords
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Ion bombardment