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Methane production from slow atomic and molecular D ion impact on graphite:[1]

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Because of its high thermal conductivity, excellent shock resistance, absence of melting, low activation, and low atomic number, there is significant technological interest in using graphite as a plasma-facing component on present and future fusion devices. This interest extends to the use of different types of graphite or carbon fiber composites (CFC's), together with tungsten, beryllium, or other refractory metals, in the ITER divertor. Although these materials have outstanding thermo-mechanical properties, they can suffer significant chemical erosion and sputtering by low energy hydrogen ion impact, which determines in large part the carbon-based-material lifetime. Due to evolving divertor design, the interest in the erosion characteristics of the carbon surfaces is shifting to progressively lower impact energies. Results are presented of chemical sputtering yields of ATJ graphite by impact of $D^+$and D_2^+ and D_3^+ in the energy range 5-250 eV/D. Our experimental approach is based on the use of a quadrupole mass spectrometer (QMS) to monitor partial pressure increases of selected mass species resulting from ion impact on the graphite surface. Due to the high D^+ currents obtainable with our ECR ion source, and the highly efficient beam deceleration optics employed at the entrance to our floating scattering chamber, comparison between same velocity atomic and molecular ion impact was possible with our apparatus at energies as low as 10 eV/D, and permitted testing of the commonly made assumption that isovelocity atomic and molecular species lead to identical sputtering yields when normalized to the D constituent number of the incident projectiles. The measurements also serve as benchmarks for new MD simulations of the chemical sputtering process that seek to incorporate more realistic many-body potentials and to expand the reaction pathway to include vibrational and/or electronic excited states.

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