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High rate deposition of hard a-C:H films using microwave excited plasmas-assisted CVD

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High rate deposition processes for hydrogenated diamond-like carbon films (a-C:H) were developed using microwave plasma enhanced CVD (PECVD) techniques. Basic investigations were carried out in a laboratory scale deposition apparatus (0.04 m^3 chamber) and after that the processes were transferred to an industrial scale PECVD machine (1 m^3) and optimized therein. The application of an asymmetric bipolar pulsed mid-frequency substrate bias allowed controlling the ion fluxes to the growing films independent on the generation of film forming species (radicals and ions) by the intense, magnetically supported microwave plasma. After preliminary experiments using five different hydrocarbon precursors, more thorough investigations were done with the precursors acetylene (C_2H_2) and isobutene (C_4H_8; isobutylene, 2-Methyl-1-propene). The a-C:H films were characterised with respect to deposition rates, hardness, abrasive wear rates, internal stresses and topography
Wear resistant, atomically smooth a-C:H films with a hardness above 25 GPa were deposited at a very high rate of 15 µm/h. The combination of high rate and high hardness values should be attractive for industrial applications, even for in-line technologies. For the both mentioned precursors C_2H_2 and C_4H_8 rather promising results were achieved. However, some differences in hardness - rate relations were observed.

Keywords
DLC
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mid-frequency bias
precursor