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Cathode Spots, Hot Spots for Impurities Release

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Local overheating, hot spots increase the influx of impurities at divertor target plates. A uniform energy deposition would be optimal. However, most discharges form small cathode spots which provide highly non-uniform energy deposition and cratering of the surface. A plasma in "contact" with a surface assumes a positive potential. The sheath electric field depends on the electron temperature and plasma density, $E \propto (n_e \, kT_e)^{1/2}$. If large enough , enhanced field emission of electrons will begin from small spots on the surface. The emission of electrons and the impact of ions stimulate desorption of neutrals from the surface of the spot. If the plasma potential is larger than the ionization energy, the field emitted electrons will ionize desorbed neutrals. Ions produced a short distance from the electron emitting spot are accelerated back toward the spot . This ion bombardment leads to surface heating of the spot. Calculations of the power deposition show that ion surface heating is initially orders of magnitude larger than joule heating by the field emission current. This ion bombardment of a thin surface layer leads efficiently to further desorption and sputtering of neutrals. The local sheath electric field increases as more ions are produced and this strongly enhances the field emitted electron current. The localized build-up of a higher plasma density above the electron emitting spot naturally leads to pressure and electric field distributions which ignite unipolar arcs. The high current density of the unipolar arc and the associated surface heating by ions provide the explosive like formation of a cathode spot plasma 1) .

1) F. Schwirzke, "Formation of Cathode Spots by Unipolar Arcing", Gaseous Dielectrics VI, Ed. by L.G. Christophorou and I.Sauers, Plenum Press, New York,1991

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