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Spots and patterns on electrodes of gas discharges[1]

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Concentration of electrical current onto the surface of electrodes of gas discharges in well-defined regions, or current spots, is often the rule rather than the exception. These spots occur on otherwise uniform electrode surfaces, a regime where one might expect a uniform distribution of current over the surface. In many cases, multiple spots may appear, forming beautiful patterns and surprising the observer. Important advances have been attained in the last 15 years in experimental investigation, understanding, and modelling of spots and patterns in discharges of different types, in particular, high-pressure arc discharges, dc glow discharges, and barrier discharges. It became clear that in many, if not most, cases there is no need to look for special physical mechanisms responsible for the formation of spots or patterns on uniform electrode surfaces: the spots or patterns originate in self-organization caused by (nonlinear) interaction of well-known mechanisms. In particular, standard mechanisms of near-cathode space-charge sheath are sufficient to produce self-organization, and it is this kind of self-organization that gives rise to cathode spots in low-current high-pressure arcs and normal spots and patterns of spots on cathodes of dc glow discharges. It was shown that spots and patterns on electrodes of gas discharges, being self-organization phenomena, are inherently related to multiple solutions, with one of the solutions describing a mode with a uniform distribution of current over the electrode surface and the others describing regimes with different spot patterns. These multiple solutions exist even in the most basic self-consistent models of gas discharges. In particular, multiple solutions have been found for dc glow discharges; the fact rather surprising by itself, given that such discharges have been under intensive theoretical investigation for many years. A concise review of the above-described advances is given in this talk.

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