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Cathodic Arc Spots: Ignition Probability as a fundamental concept to describe spot types, phases, apparent motion, and other features

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Cathodic (vacuum) arc spots are known to produce plasma of the cathode material via non-stationary processes. Much research has been done over decades to elucidate the nature of the solid-to-plasma phase transitions, many data have been collected, and models have been developed. Despite considerable progress, a coherent picture is only beginning to evolve due to the difficulties associated with small scale and short characteristic times, and the complexity of physical processes and environmental conditions. In this work, the stochastic nature of spot processes is emphasized by considering a variety of experimental observations from the point of view of ignition probability. The concept of ignition probability is based on the assumption that many locations on the cathode surface are potentially the location for the next active spot or spot fragment. Spot or spot fragment ignition occurs when a critical electrical surface field is reached at one or several of these locations. The critical surface field is a function of the surface condition and cathode material, and the momentary, local surface field depends on the local plasma density as well as on local field enhancement factors. Once a location became active, i.e., a microexplosion occurred, other locations cease mainly because their local power density has become relatively small. With the ignition probability approach, a number of experimentally observed phenomena such as spot types and apparent random or steered spot motion can be interpreted in a consistent manner, thereby eliminating some apparently conflicting statements of various arc spot models.