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of electricity generation, transmission and distribution, which are inherently related to high voltage. Diagnostic methodologies that are comprised of sets of measuring devices and systems used to assess the condition of these objects as well as the possibilities of their further operation are of fundamental importance in the strategies of operating electrical devices in the above-mentioned areas. With regard to high voltage electrical power equipment, diagnostic investigations mainly concern the insulation systems (which are the main structural elements of these devices). Unavoidable operational exposures (which primarily include the electric field in high-voltage insulation systems) are the causes of partial discharges (PDs), which initiate degradation processes in the dielectric structures. Partial discharges in high-voltage electrical devices are the main threats to their failure-free operation and apply to all groups of such devices. The lifetime and endurance of electrical high-voltage insulation is determined by its integrity and is expressed by the presence of partial discharges; these are the phenomena occurring in the internal structure of dielectrics or on their surfaces that lead to gradual degradations and, ultimately, breakdowns.

Understanding the underlying mechanisms in high-voltage insulation is an actual research topic; it refers to gaseous, solid, and liquid dielectric materials that are subjected to all kinds of electrical stresses (i.e., with alternating and direct voltage and caused by power electronics devices and various types of voltages with impulse waveforms). The key problems in the field of partial discharges include research on the mechanisms of these phenomena in dielectrics (especially in synthetic polymers intended for high- and ultra-high-voltage insulation systems) as well as the issue of initiating discharges in uniform and non-uniform electric fields in homogeneous and heterogeneous insulation materials. Another field is the interaction of discharges in their gaseous sources with the surrounding solid dielectric and the effects of the energy impact of discharges on the structures of dielectrics and their erosive effects that gradually lead to insulation breakdown. Further topics include the dynamics of the