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Reactive species in non-equilibrium atmospheric-pressure plasmas: generation, transport, and biological effects

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Non-equilibrium atmospheric-pressure plasmas have recently become a topical area of research owing to their diverse applications in health care and medicine, environmental remediation and pollution control, materials processing, electrochemistry, nanotechnology and other fields. This paper focuses on the reactive electrons and ionic, atomic, molecular, and radical species that are produced in these plasmas and then transported from the point of generation to the point of interaction with the material, medium, living cells or tissues being processed. The most important mechanisms of generation and transport of the key species in the plasmas of atmospheric-pressure plasma jets are introduced and examined from the viewpoint of their applications in plasma hygiene and medicine. The large amount of experimental data is supported by the theoretical models of reactive species generation and transport in the plasmas, surrounding gaseous environments, and plasma interaction with liquid media. Special attention is paid to biological effects of the plasma-generated reactive oxygen and nitrogen (and some other) species in basic biological processes such as cell metabolism, proliferation, survival, etc. as well as plasma medicine applications. Challenges and opportunities of future research are discussed.