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Striations due to Kinetic Instability in Water Containing Atmospheric Pressure Plasmas[1] E. KAWAMURA, M.A. LIEBERMAN, A.J. LICHTENBERG, Univ of California - Berkeley — Narrow gap atmospheric pressure plasmas (APPs) have wide ranging energy and biomedical applications. Common feedstock gases are helium and argon with trace H2O vapor. Discharge control for applications requires stability, but kinetic particle-in-cell (PIC) simulations of rf or dc driven narrow gap (1–4 mm) helium or argon APPs with trace H2O vapor show an ionization instability resulting in striations (spatial oscillations) in the bulk plasma. These striations are due to non-local electron kinetics and would not be observed in commonly used APP fluid simulations. We develop a striation theory which agrees well with the PIC results. Discharges with lower ion mobility μ_i and higher $K_{\rm rec}n_0$ tend to be more unstable, where $K_{\rm rec}$ is the electron-ion recombination rate coefficent and n_0 is the bulk plasma density. Water-containing APPs tend to form high mass positive ion clusters with high $K_{\rm rec}$ and are thus more likely to exhibit striations. APPs with argon rather than helium feed stock gas are more unstable due to the reduced (stabilizing) μ_i in the heavier gas. Water-containing APPs operated at a low frequency of 50 kHz introduce a new phenomenon of time-varying n_0, which leads to a time-varying instability.

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