Contraction and stability of the positive column of a self-sustained glow discharge in a reactive mixture[1] HONGTAO ZHONG, MIKHAIL SHNEIDER, YIGUANG JU, Princeton University — Weakly ionized plasma in a glow discharge is known to contract from a homogeneous volumetric state into a filamentary channel when the energy input exceeds some threshold. This contraction is critical for various plasma applications. In this work, the stability analysis is performed for the positive column of a self-sustained glow discharge in a reactive mixture. A zero-dimensional plasma model is first formulated by including equations for the electron/ion number densities, molecular species densities, gas translational temperature and vibrational energy. By perturbing the plasma model with plane waves, dispersion relations involving cyclic frequency and physical parameters could be analytically derived and numerically solved. The critical points physically correspond to the transition from homogeneous stable state to the contracted unstable state. This transition is shown to be not only affected by the well-known ionization-thermal mechanism, but also chemical heat release/absorption and chemical kinetics. The stability analysis will advance the understanding of interactions between weakly-ionized plasma and chemical kinetics, which is of practical interest for plasma assisted chemical synthesis and material processing.

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