Keep-in-Touch meeting
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Underlying mechanisms of discharge contraction in a CO_2/CH_4 microwave plasma

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We study discharge contraction in a MW plasma at sub-atm pressure, operating in CO_2 and CO_2/CH_4 mixtures, and compare our results against the different mechanisms proposed for this phenomenon. In particular, the addition of CH_4 alters the thermodynamic properties of the mixture, especially the reactive component of the thermal conductivity. In turn, the pressure threshold at which the plasma filament can be observed is shifted towards higher values, because further intensification of associative ionization is needed to overcome the higher inertia towards gas heating. In addition, we find that a prerequisite to express this contraction mechanism is the dominance of core heat conduction over convective forces, which is descriptive of the flow pattern in a forward vortex configuration. On the other hand, when the vortex is reversed and convection becomes the primary heat loss mechanism from the plasma zone, intense cooling prevents discharge thermalization and the onset of filamentation. Moreover, outstanding features of the reverse vortex configuration are experimentally uncovered for the first time. In particular, we see a substantial reduction of carbon deposition inside the reactor, allowing operations even in pure CH_4 feed gas, and a strong non-equilibrium between electron and translation temperatures, along with high electron density.