Optimization of H$_2$ Production in Ar/NH$_3$ Micro-discharges$^1$

RAMESH ARAKONI, ANANTH N. BHOJ, University of Illinois, MARK J. KUSHERNER, Iowa State University — Hydrogen powered vehicles and portable fuel cells may require real-time generation of H$_2$ to provide fuel safely and with rapid response. One such method is to produce H$_2$ from feedstock gases that can be more safely stored, such as NH$_3$. Microdischarge plasmas are being investigated as a means of H$_2$ production from NH$_3$ and other gases. The high power densities (10s kW/cm$^3$) that can be obtained in microdischarges provide an intense source of electron impact as well as thermal decomposition of the feedstock gases. By operating at high pressures (> 100s Torr), reformation of the dissociated products leads to efficient production of H$_2$. In this work, results from a computational investigation of production of H$_2$ in high pressure microdischarges sustained in Ar/NH$_3$ mixtures will be discussed. Plug-flow and 2-dimensional plasma hydrodynamics models were used to develop scaling laws to optimize the energy efficiency of the process (e.g., eV/H$_2$ molecule produced). The 2-d model resolves non-equilibrium electron, ion and neutral transport using fluid equations. The microdischarge geometry of interest is a sandwich flow-through reactor with a central hole a few hundred microns in diameter, power of a few W and residence times of a few microseconds.

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