# Theoretical Investigation of CMH Lamps Ignition Properties in Ar/Hg Penning Gas Mixtures

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## Abstract

Ceramic metal halide (CMH) lamps have gained more and more popularity because of their high efficiency and good colour rendering properties. It has already been reported that the breakdown voltage can be lowered in several ways from the level needed by pulse-ignited lamps [1].
In this work, results from experiment and a two-dimensional plasma transport model will be used to investigate fundamental issues in lamp starting using Ar/Hg penning gas mixture. The intent of this work is to provide insight into possible design rules that might be applied to the improvement of start-up in moderate pressure metal halide lamps.
A self-consistent fluid model was developed in Comsol Multiphysics® Plasma Module for studying the discharge phenomena. The model gives a complete description of spatial- and time evolution of the discharge plasma. Electron energy distribution function (EEDF) is calculated by solving zero-dimensional Boltzmann equation. Rate equation analysis over 30 reaction processes between 8 atomic, ionic and molecular states of argon and mercury including electron-, heavy-body collisions are taken into account.The major physical quantities are monitored such as transport of particles and transport of momentum, generation and recombination, electron particle densities and electron energy densities; chemical reactions in the plasma. The overall characteristic derived from experimental data has been well described, with reasonable agreement.
The results indicate that the Penning effect has a strong influence on the breakdown voltage, therefore this feature is often used to lower the breakdown voltage in CMH lamps. At low Hg vapor pressure (~350K gas temperature) the results show significant voltage reduction at startup, while large partial pressures of mercury considerably deteriorate discharge ignition efficacy.

## Reference

1. Brian Lay, Richard S Moss, Shahid Rauf and Mark J Kushner, Plasma Sources Sci. Technol. 12 8–21(2003)