MODELING OF MERCURY-FREE HID LAMPS: KINETICS AND THERMODYNAMCS*

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In mercury-free high-intensity-discharge (HID) lamps, mercury is often replaced by ZnI_2. This substitution, along with the use of conventional metal halides such as NaI and ScI_3 add both complexity and potential variability to the system. For example, has been experimentally determined that the lamp operating voltage is dependent or can be controlled by varying the amount of ZnI_2. This in turn has implications on the design of lamp components. The composition of the plasma, and electrical and thermal properties of the lamp are strongly influenced by the dosage of ZnI_2.

In this talk we report on the results from a computational investigation of the plasma properties of HID lamps having different metal halide fillings. The lamp resembles a D4 having initial mixtures containing Xe, ScI_3, ZnI_2 and NaI. The model used in this work, *nonPDPSIM*, is a plasma hydrodynamics model in which continuity, momentum and energy equations are solved for charged species with solution of Poisson's equation. The model is coupled with a thermodynamics module providing local thermodynamic equilibrium (LTE) properties. Algorithms were developed to represent the transition of the lamp from a kinetics-Poisson regime during breakdown to an LTE-ambipolar regime as the arc begins to form. During the LTE phase, the plasma composition is given either by a kinetics description or by LTE-derived densities on a point-by-point basis in the lamp.

The plasma composition, and the effects of mixing, segregation and ionization of light and heavy additives on thermal, electrical conductivity and I-V characteristics will be discussed. The thermodynamic database constructed for these doses will also be discussed.

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