BARIUM TRANSPORT IN FLUORESCENT LAMPS

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Loss of emitter material from the electrodes in fluorescent lamps, an inevitable consequence of the electrodes' normal operation, has several undesirable consequences, including end-darkening, consumption of mercury, and, perhaps most significantly, the ultimate demise of the electrode and, therefore, of the lamp. Although all atomic species that are present in the emitter are to some degree lost from the electrode, the loss rate of barium is considerably the largest, at least during the bulk of lamp life. The loss of barium is intimately connected to the environment into which the atoms find themselves upon removal from the electrode. This includes both the constituents of the environment (buffer gas, plasma, beam electrons) as well as its geometrical configuration (shape of tube, location of electrode within the tube, presence of other structures within the tube volume). In order to better understand emitter loss and its consequences, we have developed a finite element based model which describes the transport of barium within fluorescent lamps. The model is time dependent, has two spatial dimensions (azimuthally symmetric) and utilizes the results of a separate time dependent electrode/sheath/plasma model, developed and described previously.[1]

The barium transport model is comprised principally of a set of differential equations for three barium species (ground, resonance, and ionic states) that describe the drift/diffusion/excitation/de-excitation/ionization processes, together with boundary conditions which represent the source (evaporated barium at the electrode) and sinks (deposited barium at all surfaces). The discharge model is a time dependent, one spatial dimensional model represented by a set of differential equations that describe conservation of particles, momentum, and electron energy in the negative glow plasma. Boundary conditions include a positive column model on one side and a zero dimensional (Langmuir-type) sheath and thermal electrode model on the other side. The discharge model calculates the time dependent sheath potential self-consistently within the context of the model. The plasma and beam densities, electron temperature, electric field, and sheath potential from the discharge model are fed into the barium transport model.

1. R. Garner, "Dynamics of plasma-electrode coupling in fluorescent lamp discharges", *J Phys D: Applied Phys*, **41**, 144010, 20 pp, 2008.