Simulation of Wall Corrosion of High-Energy-Discharge Lamps

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ABSTRACT

Today High-Intensity-Discharge-Lamps are used in many domains. Parts of these domains are shopping malls, cars and sport stadiums. The life time of this type of lamp plays an important role both under ecological and economical aspects. The life time of these lamps is among other reasons limited by the corrosion of the wall materials of the lamp burner. Because of the extremely high temperatures the lamp burner consists in many cases of polycrystalline aluminum oxide (PCA). The corrosion or rather the rearrangement of the wall material depends directly on the used salt mixture; the main purpose of these filling materials is of course the control the colour of the generated light.

To simulate the influence of the salt mixture on the life time an algorithm was developed on the basis of the Cooperative Transport Model. This algorithm was implemented using SimuSage together with a lamp specific thermodynamic database. The algorithm utilizes two equilibrium reactors, which are named source and sink in accordance with the Cooperative Transport Model. The temperatures as well as the volume of these reactors are parameters, which can be adjusted. In the presented calculations always the same volume for both reactors is used. Other input parameters are the filling amounts of the salts. Additionally an iterator was used to account for the influence of time. Thus the equilibrium calculations of source and sink can be repeated until a set point.

The corrosion corresponds to the amount of transported aluminum oxide, which is initially only located in the source. Experiments have been executed in order to validate the calculation results of the simulations. Vessels made of polycrystalline aluminum oxides were annealed in a gradient furnace for these experiments. Images of the inside of the vessels were made with a Scanning-Electron-Microscope (SEM). These images show the surface change of the wall caused by the rearrangement of the aluminum oxide. The intensity of the corrosion, which is caused by the different salt mixtures, was determined on the basis of these pictures. A comparison with the respective simulations showed good agreement.