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Simulations of thermal Rayleigh-Marangoni convection in a three-layer liquid-metal-battery model[1] THOMAS KOELLNER, University of California at Santa Barbara, THOMAS BOECK, JRG SCHUMACHER, Technische Universitt Ilmenau — Operating a liquid-metal battery produces Ohmic losses in the electrolyte layer that separates both metal electrodes. As a consequence, temperature gradients establish which potentially cause thermal convection since density and interfacial tension depend on the local temperature. In our numerical investigations, we considered three plane, immiscible layers governed by the Navier-Stokes-Boussinesq equations held at a constant temperature of 500C at the bottom and top. A homogeneous current is applied that leads to a preferential heating of the mid electrolyte layer. We chose a typical material combination of Li separated by LiCl-KCl (a molten salt) from Pb-Bi for which we analyzed the linear stability of pure thermal conduction and performed three-dimensional direct-numerical simulations by a pseudospectral method probing different: electrolyte layer heights, overall heights, and current densities. Four instability mechanisms are identified, which are partly coupled to each other: buoyant convection in the upper electrode, buoyant convection in the molten salt layer, and Marangoni convection at both interfaces between molten salt and electrode. The global turbulent heat transfer follows scaling predictions for internally heated buoyant convection.

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