

Simulation of the electrochemical coating process of open-cell foams

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ABSTRACT

A growing prosperity of an expanding world population leads to an increasing demand for materials. Application-optimized materials such as foams provide greater sustainability and cost savings. By coating these cellular media using electrodeposition, the material properties can be further optimized in relation to their weight. During the coating process, significant coating thickness inhomogeneities occur, which simultaneously lead to inhomogeneous material properties. The inhomogeneities prevent an optimal material use and are caused by mass transport limitations. Hybrid foams must be coated more homogeneously in order to make optimum use of the resources. This motivates an investigation of the influencing parameters on the electrodeposition process and a simulation of the process to determine optimal process parameters for homogeneously coated open-cell hybrid foams.

The modelling of the electrodeposition process includes a convection, diffusion, migration and sink term which are linked by the continuity equation. The velocity of the electrolyte through the foam, the diffusion constant, the electric field and the deposition rate influence the local coating thickness distribution. By changing the coating thickness, the permeability of the foam changes which has an influence on the convection. Also the inner surface of the foam changes due to the thickness of the layer, thereby there is a variation in the current density and finally in the migration and the sink term. Therefore, the electrodeposition process is a fully coupled multi-field problem.

In this work the influence parameters on the electrodeposition process are investigated. The numerical implementation is done with C++ using finite differences. The electrodeposition process is a convection-controlled problem. So the first-order upwind scheme is used to discretize convection and a central difference quotient is used to discretize diffusion and migration. The sink term is assumed to be linear and the function values at the respective points are used.

By investigating the influence parameters on the electrodeposition process, optimal process parameters are to be found so that the foams are coated as homogeneously as possible and thus have as homogeneous material properties as possible.

REFERENCES

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