

A temperature dependent multi-ion model for numerical simulation of electrochemical processes
Application to electrochemical machining

Daan Deconinck

Metal removal using electrochemical machining is achieved by the controlled electrochemical dissolution of an anodically polarized workpiece. A cathode tool and anode workpiece are immersed into an electrolyte solution and subjected to a potential difference, causing electrochemical reactions to occur at the electrode--electrolyte interfaces. In particular, at the anode--electrolyte interface, metal is dissolved into metal ions.

With the aim of improving the reliability of industrial reactor simulations, this thesis introduces new models and numerical techniques for accurately calculating the flow field, temperature and potential distributions and species concentrations in an electrochemical reactor. The combined presence of electrolyte flow, electrical conduction, species convection and diffusion, ion migration under an electric field, electrochemical reactions, heat generation and heat transfer make the modeling and numerical simulation of electrochemical machining an extremely challenging procedure. An accurate prediction of shape evolution during electrochemical machining therefore requires a complex combination of models which should be adequately capable to handle electrochemistry as well as fluid flow and thermal effects on a geometry that changes over time.