

Peter Gudmundson's KTH Solid Mechanics seminar "Micromechanics of lithium-ion battery electrodes"

Mechanical degradation of electrodes is one of the main mechanisms for loss of battery efficiency and long-term properties. Experiments have revealed that cracks of different types may develop on micro- and meso-scales. Examples are electrode particle cracking, particle-binder delamination, binder cracking, electrode layer fracture, delamination and buckling. The cracks are evolving with the number charging and discharging cycles of the battery and they are thereby causing a degradation that is developing with the number of cycles.

In order to improve the performance of lithium-ion batteries it is of importance to have reliable mechanical models that can be used for optimization of battery design and operating conditions. The present seminar is focused on micro- and meso-mechanical models for constitutive description of electrodes. The models are coupled to corresponding electrochemical models mainly through the swelling and shrinking of electrode particles that result from charging and discharging.

A range of models developed in the battery group at Solid Mechanics will be discussed and compared to experimental results as

well as to data from literature. In

particular, analytical particle contact models similar to powder compaction models will be presented as well as corresponding finite element and discrete element models of representative volume elements. Monte Carlo based statistical simulations of contact forces and mesoscopic stiffnesses resulting from finite element simulations will as well be discussed. For simulation of stresses and deformation on the scale of electrode layers in a complete battery, a homogenized mechanical-electrochemical model based on three-dimensional laminate theory is presented. The seminar will end with a discussion on future plans.



Peter Gudmundson

is since 1992 professor in Material Mechanics at KTH. He has a MSc in Engineering Physics (1979) and a PhD in Solid Mechanics (1982) both from KTH. During the years 1979-87, 1989-93 he worked in industry as research engineer (Brown Boveri Research Centre, Switzerland), consultant (Tre konsulter AB, Vaxholm) and CEO (SICOMP, Piteå) respectively. He has been head of the department of Solid Mechanics (1993-2005), Vice-Dean of faculty at KTH (2007) and president of KTH (2007-16). Over the years the research has covered areas like vibration analysis, fracture mechanics, composite mechanics, paper mechanics, microelectronic devices, viscoelasticity, acoustic emission, strain gradient plasticity, lithium-ion batteries. In recent years the research has focused on micromechanics of lithium-ion batteries and strain gradient plasticity. Gudmundson is also continuously giving courses on BSc, MSc and PhD level.

