Fakultät für Mathematik
Chemnitzer Mathematisches Colloquium

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Uncertainty Quantification in Multiphase Corrosion Systems

Corrosion processes are inherently complex and multiscale, governed by highly nonlinear interactions between evolving chemistry, microstructure, and mechanics, all under substantial environmental and data-driven uncertainty. Corrosion of light metals introduces additional challenges: reactive and often porous surface films form dynamically, requiring explicit resolution of ionic transport, local pH variations, and film breakdown and re-passivation mechanisms to reproduce observed behavior. In aluminum and magnesium alloys, galvanic interactions with second phases and protective coatings further generate localized micro- environments that cannot be homogenized without sacrificing essential physical mechanisms. Even when predictive models are available, maintaining a digital twin that remains synchronized with a real component demands dense, high-quality sensing, efficient solvers, and robust data assimilation strategies, requirements that are particularly difficult to meet in corrosion systems. These challenges are compounded by the presence of multiple, interacting sources of uncertainty associated with material properties, environmental conditions, model structure, and parameter estimation. Uncertainty quantification (UQ) in this context therefore requires both deep physical insight and significant computational resources. Traditional UQ approaches can capture uncertainty but often rely on fully intrusive techniques that demand extensive modifications of governing equations. Non-intrusive methods, by contrast, treat models as black boxes, enabling uncertainty analysis without altering model structure, but at the cost of limited exploitation of internal physics. Between these extremes, semi-intrusive UQ methods offer a strategically balanced alternative. By introducing targeted modifications, such as replacing computationally expensive sub-models with efficient surrogate representations, these approaches significantly reduce computational cost while retaining key physical fidelity. This talk will discuss how such semi-intrusive strategies provide a practical and scalable pathway for uncertainty quantification in complex multiphase corrosion systems.
Das Kolloquium wird von Frau Prof. Dr. Imma Valentina Curato geleitet.

Zeit: Donnerstag, 05.02.2026, 16:00 Uhr
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