UNIVERSITÀ DI TRENTO

Electrochemo-poromechanics of ionic polymer metal composites: Theory and numerics

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Time	**15.30–16.30**
Room	**2R, DICAM, Mesiano**

Ionic polymer metal composites IPMCs consist of an electroactive polymeric membrane plated with metal electrodes and including a fluid phase, constituted by ions dispersed in a solvent, whose motion allows for actuation and sensing applications.

Here, the IPMC behaviour is studied through a large deformation electrochemo-poromechanical theory extending the recent proposal of Leronni and Bardella (2021, J. Mech. Phys. Solids 148, 104292). The theory couples the linear momentum balance, the mass balances of solvent and mobile ions, and the Gauss law, thus providing the capability to model peculiar IPMC features, such as the back-relaxation in actuation and the discharge under a sustained mechanical stimulus in short-circuit sensing, both phenomena being aided by the cross-diffusion of solvent and ions. The present extension abandons the assumption that the fluid phase is a dilute solution, leading to significant benefits on both the modelling and the computation.

A reliable finite element (FE) implementation of theories suitable to capture the IPMC multiphysics is particularly challenging because the IPMC behaviour turns out to be governed by boundary layers (BLs) occurring in very thin membrane regions adjacent to the electrodes, where steep gradients of ion and solvent concentrations occur. To address this issue, here, the generalized FE (GFE) method is adopted to discretise the BLs. The GFE implementation allows one both to apply large external actions compatible with experiments (e.g., up to 3 V drop across the electrodes in actuation) and to obtain accurate predictions in a reasonable computational time.

Finally, the modelling of some experimental results from the literature demonstrates the potential of the novel theory to be an effective tool for the thorough analysis and design of IPMCs.

The seminar is organized by the Solid and Structural Mechanics Group [D. Bigoni, F. Dal Corso, L. Deseri, D. Misseroni, M.F. Pantano, A. Piccolroaz, N.Pugno, R. Springhetti]