XIX International Conference on Computational Plasticity, COMPLAS 2027
September 6-10, 2027, Barcelona, Spain

NEW ALGORITHMS FOR INTEGRATION OF FINITE-STRAIN PLASTICITY, DAMAGE AND REGULARIZED/NONLOCAL MODELS

PEDRO AREIAS[*], TIMON RABCZUK[†] AND NUNO SILVESTRE[*]

[*] IDMEC, Department of Mechanical Engineering, Instituto Superior Técnico, Universidade de Lisboa
Av. Rovisco Pais 1, 1049-001 Lisboa, Portugal
pedro.areias@tecnico.ulisboa.pt, nsilvestre@tecnico.ulisboa.pt

[†] Institute of Structural Mechanics, Bauhaus-Universität Weimar
Marienstraße 15, 99423 Weimar, Germany
timon.rabczuk@uni-weimar.de

ABSTRACT

The return-mapping algorithm on the multiplicative decomposition $\mathbf{F} = \mathbf{F}^e\mathbf{F}^p$—comprising elastic trial, closest-point projection, and consistent algorithmic tangent—is the innermost kernel of every implicit finite-strain plasticity code. Classical backward-Euler integrators lose robustness for non-smooth or multi-surface yield criteria, large strain increments in crystal plasticity, and coupled plasticity–damage or plasticity–phase-field formulations. This mini-symposium addresses algorithms that improve, extend, or replace the standard return map and the global solvers it couples with.

Topics include: (1) Semi-implicit integration and operator splitting—explicit–implicit splits on $GL^+(3)$, IMPL-EX extrapolation, staggered crystal-plasticity algorithms with dynamic relaxation across slip systems. (2) Optimization-based and non-smooth return mapping—SQP, augmented Lagrangian, trust-region, and interior-point formulations; semi-smooth Newton with NCP functions for vertex-type yield surfaces; variational constitutive updates. (3) Data-driven integration and automated model discovery—PINN-based Gauss-point solvers, neural-ODE for internal-variable evolution, physics-constrained NN yield functions (ICNNs, polyconvex PANNs), symbolic-regression discovery of hardening laws. (4) Stochastic plasticity integration—polynomial chaos and Bayesian inference of internal-variable trajectories. (5) Gradient-enhanced and nonlocal finite-strain plasticity—implicit-gradient, micromorphic, strain-gradient formulations; Lip-field regularization. (6) Phase-field fracture coupled with finite-strain plasticity—staggered vs. monolithic solvers, Anderson and Schur-complement acceleration, ductile fracture with kinematic hardening, phase-field fatigue.

The unifying thread is the finite-strain plasticity integration algorithm—from the local return map to the global coupled solver. The aim is to cross-fertilize strategies across constitutive frameworks and communities (computational plasticity, optimization, machine learning, stochastic mechanics).