

**A semismooth Newton method for implicitly
constituted flow**

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We propose a semismooth Newton method for non-Newtonian models of incompressible flow where the constitutive relation between the shear stress and the symmetric velocity gradient is given implicitly; as a motivating example, we consider the Bingham model for viscoplastic flow. The proposed method avoids the use of variational inequalities and is based on a particularly simple regularisation introduced recently by Bulíček et al., for which the (weak) convergence of the approximate stresses is known to hold. The system is analysed at the function space level and results in mesh-independent behaviour of the nonlinear iterations.