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Coupled discretization of multicomponent diffusion problems in equilibrium and non-equilibrium plasmas KIM PEERENBOOM, JAN TEN THIJE BOONKKAMP, JAN VAN DIJK, GERRIT KROESEN, Eindhoven University of Technology — Solving balance equations is the essence of any fluid simulation of reactive, multicomponent plasmas. For plasmas in chemical non-equilibrium, balance equations are solved for all species of interest. When reactions are very fast with respect to transport time scales – and the plasma approaches chemical equilibrium – species abundances can be obtained from equilibrium relations. However, in many cases, balance equations still need to be solved for the elements, since the elemental composition can vary significantly in reactive multicomponent plasmas. Both in equilibrium and in non-equilibrium the species diffusive fluxes in these balance equations are governed by the Stefan-Maxwell equations. The use of Stefan-Maxwell diffusion leads to a coupled set of balance equations. Furthermore, this coupled set of equations is subject to charge and mass conservation constraints. Due to these complications the set of balance equations is often artificially decoupled to fit in the traditional finite volume discretization schemes and the constraints are explicitly applied. This approach can lead to very poor convergence behavior. We will present a new approach using a finite volume discretization scheme that takes into account the coupling and treats the constraints implicitly.

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