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Thermo-Mechanical Wave Propagation in Materials with Internal State Variables

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Conditions imposed on the initial data by the assumption that an acceleration wave may propagate in a termo-visco-plastic material and its amplitude blow-up to infinity in finite time are discussed. Full termomechanical coupling in 3D case is considered. Constitutive model is derived from a free energy function taking into account the non-negativity of entropy production. Thermal properties are characterized by the dependence of the heat flux on the gradient of a new thermal variable called the semi-empirical temperature scale. The theory leads to a modified model of thermo-elasto-viscoplasticity with an extra thermal stress effect and wave-type heat conduction. In the case of plane waves the solution is constructed numerically even beyond the point where Lipschitz continuity is lost and a shock with finite amplitude arises. Conditions under which a pure mechanical disturbance generates thermal one and the both may lead to blow up are established. Such a situation can model the ultimate state of a viscoplastic material in the vicinity of the dynamically propagating crac tip.

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