# CRITICAL DYNAMICS OF CONDENSED MATTER UNDER INTENSIVE LOADING

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Experimental studies of the behavior of condensed matter in a wide range of loading intensities show the limitations of the assumption of "adiabatic subordination" of mechanical properties to structural variables reflecting the behavior of defects. Deformation processes under shock-wave and dynamic loading are characterized by loading times close to the times of defectkinetics, structural relaxation, and the stages of crack initiation and propagation. This requires consideration of the deformation and fracture process, justification of thermodynamics in terms of structural variables characterizing defects, the relationship of thermodynamics with relaxation properties and the stages of fracture.

Developed in [1] statistical thermodynamics of media with defects (microcracks, microshears) established the type of thermodynamic potential (nonequilibrium free energy) depending on internal variables: deformation induced by defects and the structural scaling parameter determining the interaction of defects. Analysis of the kinetics of defects taking into account the nonlinearity of the thermodynamic potential showed the relationship of collective modes of defect ensembles (autowave and dissipative blow-up structures), which have the nature of self-similar solutions, with the mechanisms of localization of plastic flow and the staging of damage, nucleation and propagation of cracks [2, 3].

The relationship between the power-law universality of plastic wave fronts, the mechanisms of adiabatic shear failure, the kinetics of propagation of fatigue cracks, the statistics of fragmentation of ceramics with the established types of collective modes has been experimentally supported [1]. Quantitative analysis of fracture surface morphology determined structural scales corresponding to the types of self-similar solutions and the dependence of model parameters on structural invariants for different stages of deformation and fracture of materials. The influence of collective defect modes on the formation of elastic-plastic fronts in metals and the mechanism of elastic precursor decay were studied; the relationship with the thermodynamics of inert and energetic materials was analyzed [2]. Methods for multiscale analysis of structural changes caused by defects were developed using X-ray tomography data as applied to wide-range modeling of material behavior. Wide-range modeling of material behavior was carried out using nonequilibrium thermodynamic potential (free energy) and evolutionary equations that take into account the influence of defects (microshears, microcracks) and their collective modes on relaxation mechanisms and fracture. The parameters of the equations are determined on the basis of quasi-static, dynamic, fatigue and shock-wave experiments, comparison with scale invariants of the morphology of fracture surfaces and X-ray tomography data. The relationship between the self-similar nature of collective modes of defects and the power universality of plastic wave fronts, the staging of adiabatic shear failure is shown.

## References

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