
Transformation Surfaces and Post-Nuclei Stages of Two-Phase Deformations¹

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We study two-phase deformations formed as a result of martensite type phase transformations and develop approaches aimed to answer to the following questions:

- Given a material, when and what two-phase structures can appear on various deformation paths? How to construct a transformation surface in strain space?
- How a material transforms from one phase state to another?

The consideration is based on the concept of phase transition zones (PTZ) formed in a strain space by all strains which can exist on the equilibrium interfaces (see, e.g. [1, 2]). The PTZ external boundaries correspond to external strains at which equilibrium new phase layers can appear. In addition to the layers we examine the opportunity of existence of new phase domains in a form of ellipsoids, cylinders and high-order laminates [3]. As a result, we construct transformation surfaces in a strain space and relate them and the local strains with the PTZ.

Then we develop models of heterogeneous deformation due to multiple appearance of new phase inclusions. We find parameters of two-phase structures (new phase concentration, the shape and orientation of new phase domains) in dependence on average strains and construct average stress–average strain diagrams on the path of the phase transformation. To take into account the interaction of ellipsoidal inclusions we develop a symmetry consistent approach [4] alternative to the effective field method [5]. We construct domains of existence of two-phase structures in a strain space and emphasize that the type of two-phase structures strictly depends on material parameters and deformation paths. Then we consider kinetics of two-phase states not far from equilibrium and give estimations of relaxation times.

References

- [1] A. B. Freidin, Y. B. Fu, L. L. Sharipova, E. N. Vilchevskaya. Spherically symmetric two-phase deformations and phase transition zones. *Int. J. Solids and Struct.* 2006, **43**, 4484–4508.
- [2] N. F. Morozov, A. B. Freidin. Phase transition zones and phase transformations of elastic solids under different stress states. *Proc. Steklov Math. Inst.* 1998, **223**, 220–232.
- [3] A. V. Cherkaev. *Variational Methods for Structural Optimization*. Springer-Verlag, New York, 2000.
- [4] E. N. Vilchevskaya, A. B. Freidin. Multiple appearances of ellipsoidal nuclei of a new phase. *Doklady Physics*, 2006, **51**(12), 692–696.
- [5] S. K. Kanaun, V. M. Levin. *Effective field Method in the Mechanics of Composite Materials*. Petrozavodsk State University, Petrozavodsk, 1993.

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