

# ON MICROSTRUCTURAL LENGTH SCALES IN SINGLE CRYSTALS

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Size effects at the micron scale constitute one of the current research topics in the mechanics of metallic materials. The interplay between internal length scales of deforming materials with external dimensions of a material sample, grain or deformation zone can significantly affect the deformation mechanisms and mechanical response. Of particular interest are length scales of microstructural origin and physical meaning which can lead to realistic predictions of the size-dependent relation between microstructural changes and overall mechanical properties.

In this talk, four selected approaches to introducing internal length scales into continuum models of inelastic single crystals are presented, along with the examples of the predicted size-dependent microstructures.

In the first approach, illustrated by martensitic microstructures in shape memory alloys undergoing phase transformation and twinning, the internal length scale is determined by the incremental energy minimization that includes interfacial energy on different scales [1]. In the second approach, illustrated by microstructures calculated using the phase-field method, another intrinsic length scale appears that is related to the physical thickness of a diffuse interface [2].

The third approach concerns ductile metal crystals subjected to plastic deformation by dislocation motion. Within the gradient plasticity framework, a natural length scale in the incremental hardening law has been derived [3] from phenomenological laws of plasticity of metals. This length scale is expressed through standard parameters of a non-gradient hardening law and related to the characteristic wavelength of dislocation patterns.

In the fourth approach, energetic or dissipative length scales are used in combination with the above natural length scale [4]. The interplay between the length-scales of physically different origin is illustrated by the examples of monotonic and cyclic deformation of single crystals. If one or another length scale ceases to play an essential role then earlier results are reproduced.

## References

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