ON THE INFLUENCE OF PHASE CONTIGUITY ON THE STRENGTH AND STIFFNESS OF TWO-PHASE POLYCRYSTALLINE SOLIDS

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The majority of structural alloys are polyphase systems. Often the mechanical properties of the phases are quite distinct. Differences arise both in the magnitude of moduli associated with stiffness and strength and in the extent to which each exhibits directionality. In such cases, the mechanical response of the alloy is strongly influenced not only by the local properties of the individual phases, but also by the spatial arrangement of the phases. Beyond the rudimentary measures given by the volume fraction of each phase are measures associated with the contiguity of each phase. Phase contiguity depends on the phase volume fraction and on the physical distribution of the phase throughout the alloy. Clearly, as the phase volume fraction increases so does the probability that the phase interconnects in all directions. If the phase is arranged in fibers or platelettes, the chances for interconnection is higher in directions coincident with these arrangements. The opportunity for a phase's properties to become predominant depends strongly on its contiguity.

In this presentation, we discuss finite element simulations of a two-phase system in which the phases have substantially different strengths. Polycrystalline specimens, comprised of thousands of crystals each discretized with 48 tetrahedral elements, were instantiated and subjected to compressive loading. Specimens were instantiated with different volume fractions of the two phases and with different spatial arrangements of the phases (uniform and layered distributions). The contiguity of each was quantified, displayed as a pole distribution, and related to the computed mechanical behavior. From these results we discuss the sensitivity of the computed responses (properties) to the level of the contiguity and the ability of discretized samples to accurately reproduce contiguity desired in the simulation.