Composite Hugoniot Synthesis Using the Theory of Mixtures

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Reprinted from *J. COMPOSITE MATERIALS*, Volume 5, October 1971

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(Received June 24, 1971)

ABSTRACT

The contemporary theory of mixtures is employed to predict the response of composites to shock loading. The composite may consist of any finite number of constituents. Jump equations expressing balance of mass, momentum, and energy for each of the constituents are presented, following the approach of Kelly [1]. These equations are then specialized to apply to a uniaxial shock wave running into undisturbed material. The resulting theory is shown to encompass constituents which undergo phase transformations and exchange thermal energy within the shock surface.

INTRODUCTION

RECENTLY, Tsou and Chou have presented a so-called control-volume approach to Hugoniot synthesis for composite materials (References [2] and [3]). The usual approach to this problem (cf. Lysne [4]; Anderson, *et. al.*, [5]; Torvik, [6]) evolves around a mass-weighted average of the constituent Hugoniots to obtain the composite Hugoniot. The approach of Tsou and Chou is somewhat different in that they employ the jump relations for mass, momentum, and energy for the composite together with certain mixture concepts relating constituent and composite densities, energies, etc. to obtain the composite Hugoniot. Tsou and Chou have successfully compared their theory with experimental results for two alloys: copper-zinc and beryllium-aluminum. Their theory is somewhat restricted, however. The possibilities of chemical reaction among the constituents, or phase transformations of a constituent are not considered. Also, it must be assumed that either (1) the constituents come into thermal equilibrium with each other within the shock surface, or (2) no heat is transferred between constituents at any time. Neither