SHOCK07-2007-000370

Abstract for an Invited Paper
for the SHOCK07 Meeting of
the American Physical Society

Grüneisen Equation of State for Condensed Media and Shock Thermodynamics

KUNIHITO NAGAYAMA, Kyushu University

Grüneisen equation of state (EOS) for condensed media in terms of pressure, volume and internal energy is suitable for description of high pressure flow problems in condensed media including shock waves. It is shown that thermodynamically formulated Grüneisen EOS can be regarded as a differential equation for internal energy along an isentrope. The differential equation has a formal but general solution for internal energy as a sum of cold part and thermal part. In this solution, the cold internal energy is given by a special solution of the differential equation, while the thermal part is a general solution represented as a product of a function of volume Θ(v) and that of entropy C(S). The volume function can be regarded as a characteristic temperature, Θ(v), whereas the entropy function C(S) is proved to be a conjugate variable of the volume function. The above mentioned formulation is possible under the assuption that the Grüneisen parameter is a function only of volume. Heat added to the system quasi-statically represented as TdS can also be expressed as Θ(v)dC(S), which means that the characteristic temperature plays a role of integrating denominator, while C(S) is a conjugate thermal variable with a new integrating denominator. Thermodynamic fomulation of the Grüneisen EOS in terms of these new thermal variables has been given. Several examples of the applications of this formulation are also given including (i) compatibility of the formulation with Debye model for the specific heat, (ii) estimation of the variable C(S) along shock Hugoniot, (iii) shock temperature calculation, (iv) Grüneisen parameter calculation by theoretical models, (v) extension to the formulation of anharmonic EOS, etc.