Table 1.3
Reviews of current status*

Duvall [62D3] (5, 30)	General
Skidmore [65S1] (36, 50)	General
Graham [67G1] (7, 43)	Technique, electronic properties
Gilman [68G2] (16, 80)	Viscoplasticity; see also [69G1]
Karnes [68K1] (23, 19)	Technique
Jones et al. [70J4] (67, 119)	Very high pressure
Jones [71J3] (11, 41)	Plastic deformation
Keeler [71K3] (13, 22)	X-ray diffraction, Brillouin scattering
Barker [72B2] (6, 27)	Interferometric technique
Carter [73C1] (13, 16)	Phase transitions
Carter [73C2] (11, 17)	Phase transitions
Duvall [73D4] (36, 42)	Applications
Clifton [74C1] (65, 96)	Viscoplasticity
Duvall [76D4] (17, 38)	Phase transitions
Curran et al. [77C2] (9, 15)	Spall

Conference proceedings

Editors	Reference	Emphasis
Shewmon and Zackay	[61S1]	Metallurgical effects
Ribaud	[62R2]	General
Williams	[63W1]	General
Jacobs	[65J1]	Principally detonation
Berger	[68B3]	General
French and Short	[68F1]	Geophysical
Jacobs and Roberts	[70J1]	Principally detonation
Kinslow	[70K2]	General
Burke and Weiss	[71B1]	General
Lloyd	[71L1]	Static and shock
Chou and Hopkins	[73C7]	Mechanical phenomena, low stress
Rohde et al.	[73R3]	Metallurgical
Osugi	[75OS1]	Static and shock, very broad
Edwards	[76E1]	Principally detonation
Varley	[76V1]	General
Manghnani and Akimoto	[77M7]	Geophysical, static and shock
Dubovitskii	[78D2]	Principally detonation, in Russian
Timmerhaus and Barber	[79T1, 79T2]	Static and shock, very broad

* Numbers in parentheses give number of pages and number of references, respectively.

2. Background

Research on shock compression of solids involves consideration of both microscopic and macroscopic phenomena; but the direct experimental observations, with very few exceptions, are made at the macroscopic level. The substance of this section is a brief summary of certain background material necessary to understand these observations. Additional background information related to electrical phenomena is given in sections 4.1 and 4.2.

2.1. Kinematical and dynamical relations

In this subsection, we discuss the motion of continuous bodies and the equations representing the principles of balance of mass, momentum, and energy as applied to such bodies. Kinematical and dynamical aspects of continuum theories of matter are discussed in great detail by Truesdell and Toupin [60T1], while simplified treatments adequate for most discussions of plane waves have been given by Cristescu [67C4], Zel'dovich and Raizer [66Z1], Chou and Hopkins [73C7], Jones [72J3, 73J1], Murri et al. [74M3], and in other general references cited in section 1.

Kinematics. In this review we consider material bodies that reside in an inertial space in which the places are denoted by Cartesian coordinates x_i, $i = 1, 2, 3$. The material points (usually called "particles", a term to be understood in the continuum sense rather than in terms of microscopic concepts) comprising the body are designated by the components X_i, $i = 1, 2, 3$, of the place they occupy when the body is in some reference configuration. The reference configuration may be, and usually is, the initial state of the material as it is about to undergo some deformation of interest. This is not necessarily the case, however, and we allow for reference to some configuration existing at absolute-zero temperature, before a prior wave interaction, etc. A motion of the body is described by a relation of the form $x_i = X_i + d_i(X_1, X_2, X_3, t)$, where the vector $\boldsymbol{d}$ represents the *displacement* of a material point from its reference position to its current position.

The components of the *particle velocity* $\boldsymbol{u}(\boldsymbol{X}, t)$ and the *particle acceleration* $\dot{\boldsymbol{u}}(\boldsymbol{X}, t)$ of the material point $\boldsymbol{X} \equiv (X_1, X_2, X_3)$ are given by the equations

$$u_i = \partial d_i/\partial t, \qquad \dot{u}_i = \partial u_i/\partial t. \tag{2.1}$$

The relative motion of neighboring material points of the body is important in studies of material behavior so the *deformation gradient* $\boldsymbol{F}$ having components $F_{ij} = \delta_{ij} + \partial d_i/\partial X_j$ and the *material strain tensor* $\boldsymbol{\eta}$ or, for small strains, the *linearized tensor* $\boldsymbol{S}$ having the components

$$\eta_{ij} = \frac{1}{2}\left(\frac{\partial d_i}{\partial X_j} + \frac{\partial d_j}{\partial X_i} + \frac{\partial d_k}{\partial X_i}\frac{\partial d_k}{\partial X_j}\right) \quad \text{and} \quad S_{ij} = \frac{1}{2}\left(\frac{\partial d_i}{\partial X_j} + \frac{\partial d_j}{\partial X_i}\right), \tag{2.2}$$

respectively, assume important roles.

The use of the spatial (also called "Eulerian" or "laboratory") coordinate frame, x, is quite common, seems very natural, and is most appropriate for problems (usually fluid dynamics) where instrumentation is fixed in space and monitors the passing flow. The material (or "Lagrangian") frame X is more appropriate for problems of solid dynamics in which instruments are fixed to the moving sample. Material coordinates are also required for the analysis of problems in which the separate material points have, or acquire, distinguishing properties.

Uniaxial strain. Most shock-compression experiments involve application of normal forces uniformly over the face of a material slab. Since the experiment is conducted in the central part of the slab, and is completed before the arrival of any wave originating at its edge, the analysis can be carried out as though the slab were of infinite lateral extent. In materials having suitable symmetry of response (for example, those that are isotropic) the coordinates can be chosen so that all material points move in the 1 direction. In this case the motion takes the form $x_1 = X_1 + d_1(X_1, t)$, $x_2 = X_2$, $x_3 = X_3$. The only non-zero components of the strain tensors corresponding to this motion are

$$\eta_{11} = \partial d_1/\partial X_1 + \tfrac{1}{2}(\partial d_1/\partial X_1)^2 \quad \text{and} \quad S_{11} = \partial d_1/\partial X_1. \tag{2.3}$$