It has become apparent that in some cases dense phases can be recovered in larger yields and with better control on crystallite size by mixing the transforming materials in a metallic host such as copper or iron [68C3, 74S5]. Porous samples have also been used to achieve higher temperatures. There is some indication that particle size of both the transforming and host materials may influence yields by changing quenching rates [77D3].

In addition to the extensive work on boron nitride, diamond and dense quartz which is discussed here in more detail, Leiserowitz et al. [66L1] have been successful in recovering dense phases of CdS, β lead oxide and calcite by adding about 10 per cent water to the samples as a quenching agent.

Boron nitride has been extensively studied because its behavior is somewhat analogous to carbon, because of the ease with which large yields of dense phases are obtained and because this hard, dense phase is of practical utility. The summary of shock-wave synthesis of dense BN given in table 3.8 shows the various investigations and their principal results. There has been almost continuous activity since 1965 and very considerable activity in the past few years.

BN was first synthesized in static-high-pressure studies of Bundy and Wentorf [63B3] who found a wurtzite form of BN, denoted wBN, and at lower temperatures a zinc blende form of BN, denoted zBN. The principal questions in shock synthesis revolve around the circumstances under which the wurtzite or zinc blende forms are obtained and the conditions which determine the yields. Resolution of such important detail has been hampered by use of tubular loading methods and the possibility of contamination. Some investigators have suggested that the identified zBN may be copper contamination while others feel that zBN is obtained when higher temperatures are achieved. In any event, it is clear that wBN is more frequently obtained and that yield depends more on the extent of crystallinity of the starting material than on the pressure. Phase stability data on samples under planar loading, analogous to those for static conditions [75C2, 75T1], are needed to clarify shock synthesis conditions.

Kurdyumov and coworkers (see table 3.8) have carried out detailed examination of fine structures in X-ray patterns on shock-synthesized BN to study transformation mechanisms. Their studies have demonstrated the crucial role that stacking faults produced by plastic deformation play in the transformation process. These stacking faults have been observed in samples recovered below the transition pressure. Kurdyumov and Frantsevich believe that the two-dimensional stacking faults are regions in which wBN cannot be transformed but may be the source of nucleation for zBN.

The synthesis of diamond has fascinated scientists for over a century. Certainly the most spectacular achievement in material synthesis by shock compression is the formation of diamond from graphite. Following the static-high-pressure synthesis of diamond with catalysts by Bundy et al. [55B1], attempts to obtain direct conversion of graphite to diamond were unsuccessful. The first direct conversion was achieved in shock-compression experiments by DeCarli and Jamieson [61D1]. Bundy reported the first direct conversion of graphite to diamond in a static pressure apparatus [63B2] in 1963. Work on this problem is summarized in table 3.8.

DeCarli and Jamieson [61D1] first proposed that transformation to diamond took place in rhombohedral graphite but not in hexagonal graphite. More recent evidence derived from fine structure in X-ray diffraction studies of recovered samples by Kurdyumov [75K4, 72K5] indicates that formation of stacking faults by plastic deformation provides a crucial intermediate step for diamond formation. DeCarli [79D2] has proposed a nucleation and growth model for diamond formation. The importance of such a model has been demonstrated by Pujols and Boisard [70P1]

Table 3.8
Material synthesis with shock loading

Authors	Reference	Observations
Boron nitride		
Batsanov et al.	[65B2]	"E" phase recovered
Adadurov et al.	[67A1]	wBN recovered, no zBN or "E" phase
DeCarli	[67D2]	both wBN and zBN recovered
Coleburn and Forbes	[68C2]	zBN recovered, trace wBN
Dulin et al.	[69D1]	recovered predominantly wBN, some zBN
Johnson and Mitchell	[72J2]	real-time flash X-ray, wBN lines
Riter	[73R2]	wBN deformation mechanism
Kurdyumov et al.	[73K3]	fine structure of wBN examined
Soma et al.	[74S5]	Cu/BN mixture; wBN recovered
Sawaoka and Soma	[74S1]	Cu/BN mixture; wBN recovered; Cu contamination to explain zBN?
Kurdyumov and Frantsevich	[75K4]	wBN recovered, copper contamination to explain zBN?
Bavina et al.	[75B3]	zBN from porous sample, X-ray interpretation?
Soma et al.	[75S2]	Cu/BN mixture; wBN recovered
Kurdyumov et al.	[75K5]	multiple shock loads; investigates untransformed products
Kurdyumov	[75K3]	crystallographic mechanisms for transformations
Kurdyumov	[76K3]	stacking faults below transition pressure
Kurdyumov	[76K4]	athermal wBN mechanism
Akashi et al.	[76A3]	multiple shock loads; wBN then zBN recovered
Nesterenko	[77N2]	Cu/BN mixture; effects of particle size
Dubovitskii	[77D5]	synthesis of borozon, polycrystalline zBN
Saito et al.	[78S1]	sintered polycrystalline zBN, wBN compact produced
Densification of vitreous silica		
Wackerle	[62W1]	densification at 25 GPa, not at 50 GPa
Deribas et al.	[66D2]	axisymmetric loading
Gibbons and Ahrens	[71G1]	index of refraction, 8 to 46 GPa
Arndt et al.	[71A6]	index of refraction, 6 to 46 GPa
Ananin et al.	[74A1]	4 to 24 GPa
Graphite to diamond		
Parsons	[20P1]	possible recovery of diamond
Riabinin	[56R1]	failed to recover diamond
DeCarli and Jamieson	[61D1]	diamonds recovered from artificial graphite
Lipschutz	[64L1]	diamonds from meteorites and artificially shocked graphite
Trueb	[68T2]	Fe/graphite mixture; yield vs. particle size, hexagonal and cubic diamond
Trueb	[70T1]	graphite "ghosts" of diamond nuclei
Pujols and Boisard	[70P1]	hard graphite from diamond microseeds, stacking faults
Trueb	[71T2]	Cu/graphite mixtures; 20–40% yield; all cubic diamonds
Fournier and Oberlin	[71F1]	recovered diamond; graphite with stacking faults
Kurdyumov	[72K5]	graphite below transition; large increase in packing defects
Vdovykin et al.	[73V1]	shock meteoritic material; diamonds recovered
Kurdyumov	[75K3]	transition mechanisms
Glass and Sharma	[76G1]	unique gaseous implosion, 5% yield of diamonds
Deribas and Staver	[77D3]	Cu/graphite, Fe/graphite mixtures
Trefilov et al.	[78T2]	control initial temperature
DeCarli	[79D2]	nucleation and growth model
Amorphous and dense quartz from α-quartz		
DeCarli and Jamieson	[59D1]	amorphous quartz recovered
Chao et al.	[60C1]	coesite, meteor crater
Chao et al.	[62C1]	stishovite, meteor crater
Wackerle	[62W1]	amorphous quartz recovered
DeCarli and Milton	[65D1]	stishovite (trace) recovered