The accuracy of the technique was checked by measuring the density of a piece of single-crystal alumina (sapphire). Two determinations gave values of 3·99 and 4·00 g ml^{-1} which are in close agreement with the published theoretical density.

4. DISCUSSION

It is evident from the results given in Table 1 that the largest strain induced by explosive shocking is greater than that induced by the severe Glen-Creston ball-milling of alumina.

There are three points worthy of note:

(a) It appears to be advantageous to use a double layer of explosive to induce higher strains.

(b) For the capsules shocked using a double layer of explosive, the powder contained in the thicker-walled capsule (A) sustained the greater strain.

(c) The spatial distribution of strain observed in the alumina powder in capsule C is not evident in the powder in the other two capsules and the process of straining the alumina therefore appears to be somewhat uncontrolled and non-uniform.

Electron-microscope observations on the powder specimen revealed that the size of the majority of the alumina particles is not severely reduced (see Table 2). This finding is consistent with that of BERGMANN and BARRINGTON.[6] The range of particle sizes is, however, considerably decreased. In addition, the electron micrographs indicated that alumina particles in different parts of the encapsulated volume undergo the process of size reduction by two essentially different mechanisms.

Firstly, particles in the region of the capsule walls undergo a process of diminution by "chipping", so that each particle is broken down gradually. In consequence, a large number of small chippings or fragments appear among the larger unaltered particles. This situation can be seen in Figure 2. Micrograph 2A shows the unshocked powder particles, whilst micrograph 2B is an example of the shocked particles in the region of the capsule walls. Many small fragments (0·1 − 0·5 μm) are evident. (For comparison micrograph 2C shows the same starting material after it has been Glen-Creston-milled for 8 h).

Secondly, particles which were situated in the central axial regions undergo a process of shattering, which leaves the particles broken into a few fragments of similar size (see Figure 3). The beginning of this process is made manifest by the appearance of small cracks (see micrograph 3A), which later develop in size until the particle is broken apart. Micrographs 3B and 3C give typical examples of various particles, which have partially or fully undergone this process, showing several cracks.

Although a certain amount of chipping is evident in the powder from the central axial region (i.e. cylinder of 2–3 mm diameter), little evidence of cracking was obtained from powder from the regions near the capsule walls (i.e. within a cylindrical annulus of 2 mm).

On further examination of the micrographs it became evident that the form of the particle size distribution varies throughout the encapsulated volume. In general, the width of the size distribution is smaller for material shocked in the central regions of the capsule cavity than for that in the regions nearest the capsule wall. The distribution with the smaller width is probably produced when the material is forced into a reduced volume during the explosive shocking, thus favouring the break-up of the initial particles into smaller fragments.

The explosive treatment of powders does not merely consist of a simple compression, as in conventional compaction processes, but involves a shock wave passing through the powder mass. The variation in the form of the particle-size distribution together with the different mechanisms of particle size reduction discussed above indicate that these shock waves have the most marked effect on the powder particles in the centres of the capsule cavities.

The explosively shocked powder did not achieve as high a density as did the Glen-Creston-milled powder. It is believed that the poor pressing characteristics of the explosively shocked powder are at least in part responsible for the lower final density.

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