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Shock synthesis diamond from apple wood ceramics

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In this paper, a method of shock synthesis of diamond from apple wood ceramic as a carbon source is presented. Experiments are carried out with a cylindrical compaction system using explosive. Apple wood ceramic, as a carbon source, is made by mixing the dried apple bagasse with phenol resin and carbonizing the mixture. The iron powder was used as catalysts. In these experiments, the pressure which acts on powder container is about 10GPa. X-ray diffraction examination of the recovered powder, confirmed the conversion of carbon to diamond.

Keyword: Shock synthesis, Apple wood ceramic, Cylindrical compaction

1 INTRODUCTION

Recently, the artificially synthesized diamond is used as a high-functional material in several fields due to its outstanding properties like excellent abrasion characteristic. Shock synthesis method has been known as one of the methods for artificially synthesizing diamond [1]. Conversion of graphite into diamond by shock pressure has been a subject of intensive study for more than 50 years. Many studies have been carried out on catalysts or solvents, graphite types and graphite conversion technology [2, 3]. Since the duration of high pressure shock is of order of micro second, it is believed that the idea on nonproliferation implantation which is direct implantation to a diamond from graphite. Therefore, good-crystalline graphite powder was being used as starting material. The recovered diamond powder is influenced by the starting graphite. During conversion of graphite, diamonds with different habits, cubic and hexagonal, could be obtained simultaneously. Moreover, in order to obtain the diamond with a yield rate of about 50%, a shock pressure of 140GPa is required. In the case of using catalysts or solvents, such special high pressure is not required for conversion of graphite into diamond. Low quality graphite powders, like apple wood ceramic, are difficult to be transformed into diamond. In this study, apple wood ceramic as a carbon source and iron powder as a catalyst, have been used to study the conversion of graphite to diamond. Three types of apple wood ceramics, obtained in different carburization conditions, were utilized in the diamond synthesis experiments using and electrolysis iron powder. The recovered samples have been characterized using X-ray diffraction method and the results are discussed.

2 EXPERIMENTAL PROCEDURE

2.1 Original materials

Three types of apple wood ceramics are used as carbon source which are made by carbonization of apple bagasse at 800, 1200 and 3000 ° C. The apple wood ceramics obtained do not have so high quality crystal structure. Fig. 1 shows the X-ray diffraction patterns of the three apple wood ceramics types used in this research. The electrolysis iron powder, average size 150 μ m, was used for catalyst.

2.2 Preparation of the samples

Three samples were made by mixing apple wood ceramics powder and iron powder. Three copper pipes were then filled with each of these samples. The pipe ends were blocked by stainless steel plugs. The initial packing density and mass ratio of powders are given in Table I.

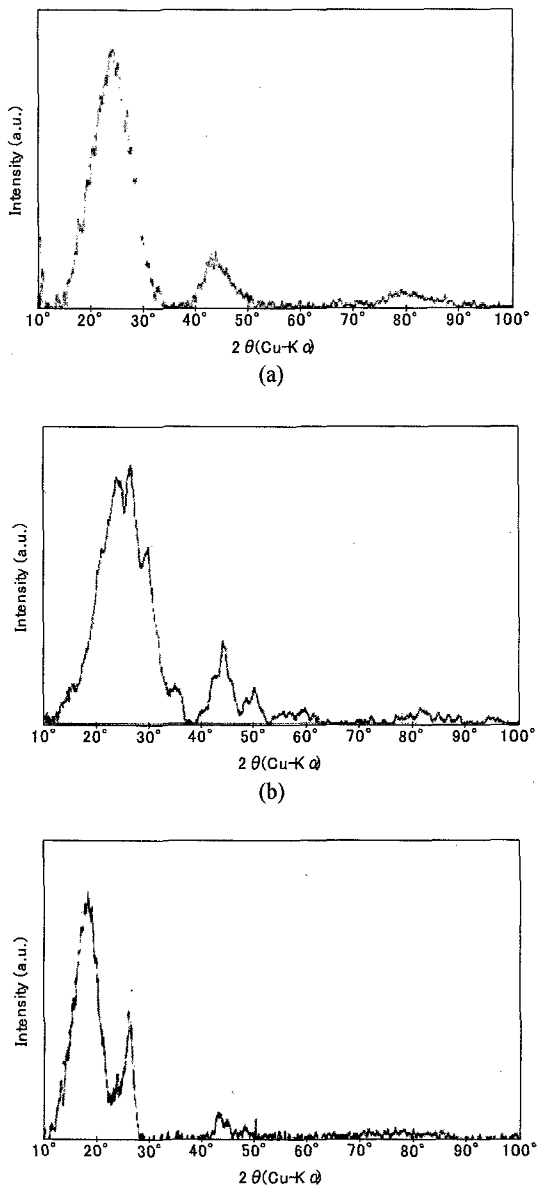

Fig. 1. X-ray diffraction patterns of apple wood ceramics, produced at carbonization temperature (a) 800° C,(b) 1200° C and (c) 3000° C.

Table I. experimental condition

No.	Composition (g)	Porosity (%)
1	Apple wood ceramic carbonized at 800℃ (10) + electrolysis iron (40)	50
2	Apple wood ceramic carbonized at 1200℃ (10) + electrolysis iron (40)	50
3	Apple wood ceramic carbonized at 3000℃ (10) + electrolysis iron (40)	50

2.3 Experimental setup

All experiments were carried out using EMX explosive (detonation velocity 4400m/s, density 900kg/m3, supplied by Nihon Yushi Corp.). Fig. 2 shows the experimental set up. The mixture of the apple wood ceramic and iron powders was placed into a copper pipe which was positioned into a PVC pipe. The space between the copper and PVC pipes was filled with the EMX explosive. Upon the detonation of explosive by an electric detonator, a maximum pressure 10GPa is applied on the powders mixture.

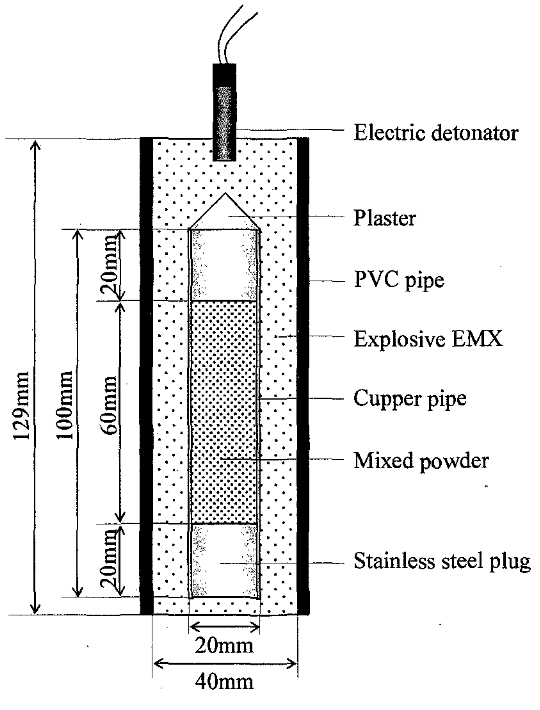

Fig. 2. Schematic illustration of experimental setup

3 RESULTS AND DISCUSSION

The recovered samples were washed by hydrochloric acid to dissolve and separate the iron particles. X-ray diffraction examination was performed on the samples. Shown in Fig. 3 are the X-ray diffraction patterns of the three compacted samples. The patterns exhibit a peak that proves the transformation of apple wood ceramic to diamond. A broad range of peaks appeared in these X-ray diffraction patterns. It is thought that a single peak doesn't appear, since the diamond generated by the shock synthesis method generally is polycrystalline consisting of ultrafine crystals (about 10nm in size) joined together [4]. Although the diamond is produced the remaining graphite part must be separated from the diamond after the process.

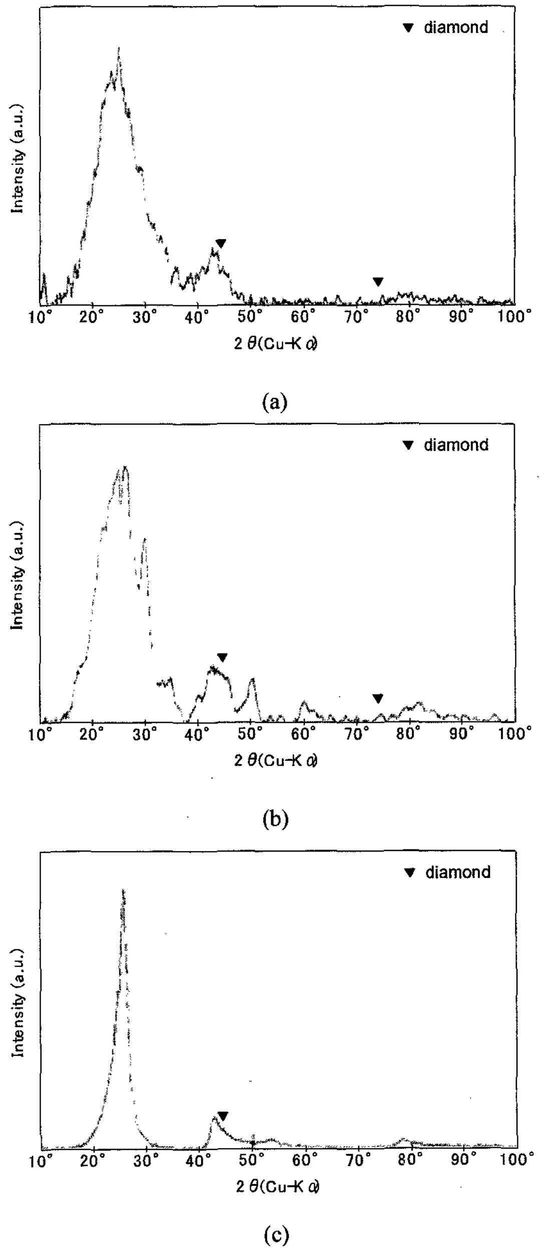

Fig. 3. X-ray diffraction patterns of recovered sample (a) No.1, (b) No.2 and (c) No.3.

4 Acknowledgements

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5 Reference

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