Effect of FeNi30 Powder Catalyst by Water Atomizing on Synthesis High-grade Diamond

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Abstract

This paper described the preparation method for composing high-grade synthetic diamond by water atomizing using FeNi30 powder catalyst. The objective of this article is about powder making process using super high water atomizing in the atmosphere of inert gas, and then corroded the powder with a corrosion inhibitor. Finally, FeNi30 catalyst powder with lower oxygen content and good sphericity is produced. The experiment of making diamonds by using cubic press and the performance of the diamonds are also discussed.

Keywords : water atomizing synthetic diamond powder catalyst inhibitor

1. Introduction

In the synthesis of diamonds,an essential material is the catalyst materials. Besides being able to reduce the transforming temperature and pressure from graphite to diamond, they can also affect the quality and crystal form of the diamond [1]. As there are various different kinds of fabricating process of Iron-based powder catalyst, the quality of diamonds differ from one another. The diamonds made by water atomizing iron-based powder are lower in quality than those made by gas atomizing iron-based powder in the following aspects: color, penetrability and TTI value. The main reasons for this are as follows: (1) Iron-based powder has low anti-oxygenic property, and the oxygen content of the powder can be increased by melting in air, water atomizing preparation process and powder deposition; (2) the shapes of water atomizing powder are complicated as fibers have many rifts, are coarse and asymmetrical surfaces, and they can be easily corroded[2]. These two reasons lower the stability of the iron- based powder. By decreasing the oxygen and impurity contents of the powder, and at the same time improving the shapes of the powder, the difference between high-grade diamond performances made by the two different kinds of processes can be reduced. The cost of manufacturing of catalyst powder can also be lowered.

2. Experimental and Results

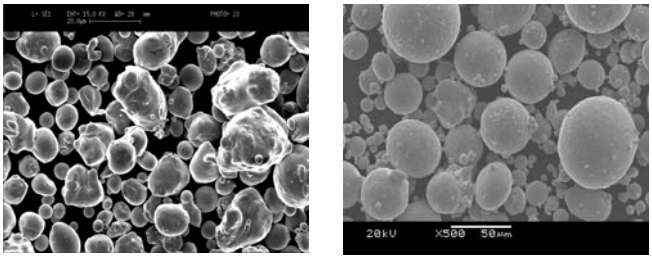
Using III angle atomizer, FeNi30 catalyst powder was made by super high pressure water atomizing. First,the atomizing powder was put into a mixer hopper. Next,a homemade solution of organic RY was added to the corrosion inhibitor with different content of 0.2 % wt, 0.4% wt and 0.6% wt, and then they are mixed for 20 minutes. At the same time, the treated FeNi30 powder was compared with the original FeNi30 powder (Numbered Exp.2) in the experiment. Finally the powder phase was analyzed by X-ray diffraction (X Pert PRO MPD). The SPD6×1200 press that was manufactured in China was used as the test equipment. -200 mesh FeNi30 catalyst powder was mixed after being corroded (Numbered Exp.1) with –200 mesh lepidosome graphite homogenously. Since the contrast between Exp.1 and Exp.2 are unchangeable after optimizing adjustment, the samples were being observed by optical microscope after pickling and purification.

The oxygen in the Fe-Ni alloy enters into the powder and reacts with little active metal and high melting point metal.

$$[O]+M \rightarrow MO$$

It forms high melting point solid inclusion which can prevent carbon from delivering into the grain and diffuse. All these affects the diamonds' growth and decreases its penetra-bility.The oxygen content can be reduced by 300~400PPM inside the powder by using N_2 protection system.

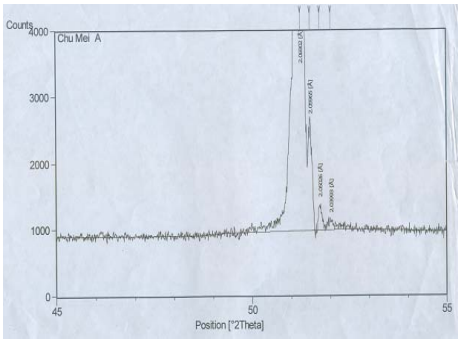
Fig.1 shows the photographs of FeNi30 powder with the atomizer of III by water atomizing and FeNi30 powder by gas atomizing. Figure 1(a) shows that atomizer angle III is in favor of the spheroidizing of FeNi30 powder by water atomizing as its shape is similar to the powder made by gas atomizing.



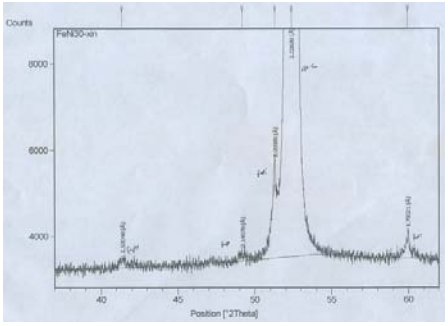
(a) Ⅲ (b) gas atomizing

Fig, 1. SEM photographs of FeNi30 powder with atomizer Ⅲ by water atomizing and FeNi30 powder by gas atomizing.

About 0.4% concentration of RY corrosion inhibitor can reduce oxygen content in powders by 2000PPM to 2500PPM.Fig.2 shows XRD spectrum of FeNi30 powders treated with corrosion inhibitor and those that were not treated with the corrosion inhibitor. As seen from the figure, neither FeO and Fe_3O_4 phase were observed in powders treated with corrosion inhibitor.



(a) Exp.1



(b) Exp.2

Fig. 2. XRD spectrums of Exp.1 and Exp.2 FeNi30 powders.

Table 1 shows the performance of diamond with FeNi30 powder catalyst after technique being optimized.

Table 1. The main performance of diamond with FeNi30 powder catalyst after technique being optimized

Sam-ple	Yield Of Persize	Color	40/50 Item		High Intensity Proportion (>18kg)
			TI	TTI	
No.1	52	Golden Yellow	83	76	22%
No.2	55	Dark Yellow	85	77	22%

3. Summary

Based on the experiments conducted in the study, the following conclusions could be drawn.

1.The oxygen content of Fe-Ni alloy melted by the nitrogen protection method can be reduced by 300~400ppm.

2.The water atomized nozzle angle helps to improve the shape of catalyst powders, which is approximated to that of gas atomized powders made by gas atomized nozzle.

3.The oxygen content of Fe-Ni powders treated by 0.4% RY corrosion inhibitor can be reduced by 2000 to 2500ppm. FeO and Fe_3O_4 phase were not present within powders as observed using XRD measurement,but after being stored under natural condition for one year, the increment of oxygen content within powders was lower than 100PPM.

4.Diamond sample that was synthesized by catalyst powders which were made by the nitrogen protection method, atomized by the nozzle angle III and treated by 0.4% RY corrosion inhibitor has higher yield per size, more saturated color, higher TI and TTI. However, it has a lower transparence than that of superior grade diamond sample synthesized by gas atomized catalyst powders. This result could be due to specific synthesis process, which requires further investigation.

4. References

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