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KOMPOZİTLERDE ORTALAMA TANECİK BOYUTUNUN ULTRASONİK ATTENUATION KATSAYISI ARASINDAKİ İLİŞKİ

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ÖZET

Bu çalışmada, tungsten karbür tozu kullanılarak hazırlanan seramik-metal kompozit numunelerin ortalama tanecik boyutları ile ultrasonik attenuation katsayısı arasındaki ilişki incelenmiştir. Numune üretim işlemlerinde tungsten karbür tozlarına electroless nikel kaplama yöntemi uygulanmıştır. Attenuation değerleri, ön ve arka cidar ekolarının ekran yüksekliklerinin ölçümlerinden hesaplanmıştır. Attenuation sonuçları, taramalı elektron mikroskobu (SEM) görüntülerinden hesaplanan ortalama tanecik boyutları ile karşılaştırıldı. Bu karşılaştırmadan numunelerin ortalama tanecik boyutunun attenuation katsayısına bağlı olduğu elde edilmiştir.

Anahtar Kelimeler: Ultrasonik, Attenuation, Kompozit, Ortalama Tanecik Boyutu

RELATION BETWEEN MEAN GRAIN SIZE AND ULTRASONIC ATTENUATION CONSTANT IN COMPOSITES

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ABSTRACT

In this study, relation between the mean grain size of ceramic-metal composite samples, made of Tungsten Carbide (WC) powders and ultrasonic attenuation constant is investigated. Electroless plating of nickel is applicated to WC powders in sample production process. Attenuation values have been estimated from measurement of screen heights of front and backwall echoes. The attenuation values have been compared with the mean grain size of samples calculated from the scanning electron microscope (SEM) images. From the comparison of results, dependence of attenuation coefficients to mean grain size of samples have been obtained.

Keywords: Ultrasonic, Attenuation, Composite, Mean Grain Size

1. INTRODUCTION

Material examination by ultrasonic methods depends on various properties of the materials, including the velocity, relative attenuation, and backscattering of sound waves in the materials. Recently there has been a great deal of interest in the ultrasonic attenuation and velocity in polycrystalline metals in conjunction with non-destructive testing, delay lines and scattering theories for ultrasound [1]. Ultrasonic attenuation measurements are usually-conducted by pulse echo techniques discussed in the literature [2]. The phase and amplitude of the back-wall echoes is varied by the wavelength and the thickness of layer formed by the couplant and wears plate of transducer. Thus, the same error would be comprised in the ultrasonic velocity and attenuation coefficient measured by the contact ultrasonic testing. Although it has been considering the coupling effect in the ultrasonic velocity measurement, there are few studies on the coupling effect in the ultrasonic attenuation measurement and the flaw detection [3].

Composite materials (or composites for short) are engineered materials made from two or more constituent materials with significantly different physical or chemical properties and which remain separate and distinct on a macroscopic level within the finished structure. In this study, relation between the mean grain size and ceramic-metal composite samples, made of Tungsten Carbide (WC), and ultrasonic attenuation constant is determined.

2. SAMPLES PREPARATION

In this work, the ceramic-metal composites were obtained by using Nickel with tungsten carbide powders and the production of ceramic-metal composites using WC powders plated with Ni by electroless method were attempted. Electroless deposition is a very simple process which can be used to obtain amorphous metallic coatings of uniform thickness on metallic or non-metallic substrates [4]. Firstly, all of the samples were prepared by mixing %70 WC and %30 Ni. And then, all the powders were placed in a 30mm diameter mold and pressed using a hydraulic press at a pressure of 360 bar. Prepared samples were sintered at the different temperatures ranging from 1000^0C to 1300 ^{0}C in an Argon atmosphere.

3. ATTENUATION MEASUREMENTS

Ultrasonic attenuation depends on both the wavelengths of the ultrasonic pulse and the sizes of the grains in a polycrystalline material [5]. Ultrasonic attenuation measurements have been realized by using Sonatest, Sitescan 150 flaw detector. Attenuation values of 2 and 4 MHz T/R transducers have been obtained directly from a property of detector. Screen and flaw detector are shown in Fig 1.

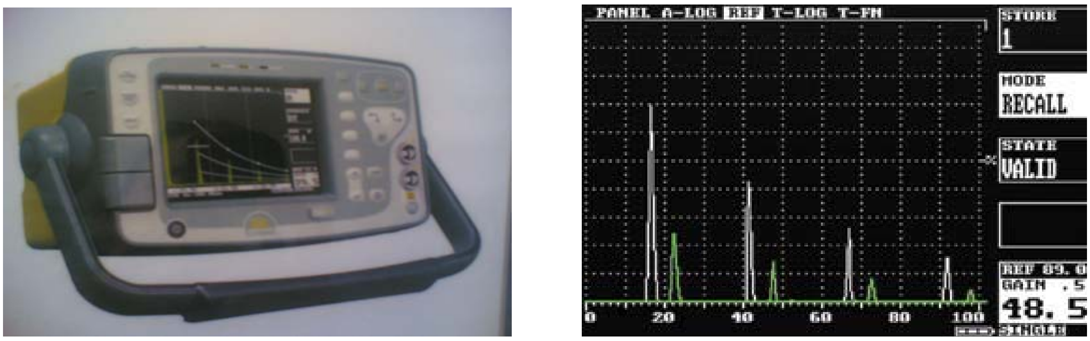

Fig. 1. Flaw detector, front and backwall echoes on screen.

Various techniques have been found to calculate of attenuation coefficient. In contact ultrasonic testing, the attenuation coefficient is generally obtained by the ratio of the amplitudes of the first back-wall echo to that of the second back-wall echo. In our study, we are used this formula for calculating attenuation coefficient as follows:

$$\alpha = \frac{1}{d} 20 \log \frac{A_1}{A_2} \tag{1}$$

where A_1 and A_2 , is successive amplitude of reflected ultrasonic wave in materials boundary respectively [6].

Attenuation measurements have been realised by measurement of decreasing of screen heights of two successive echoes under the same gain. Measurement of attenuation values are shown in Table 1.

Table 1. Measurement of attenuation values of samples.

Samples	T_S (°C)	Attenaution values (dB/cm) 2 MHz	Attenaution values (dB/cm) 4 MHz
1	1000	2.9	2.94
2	1100	2.36	2.4
3	1200	1.89	1.93
4	1300	1.23	1.46

Ultrasonic mean grain size determination of solid materials can be performed by several techniques which are dependent on ultrasonic quantities such as ultrasonic attenuation, ultrasonic backscattering, and velocity [7]. The mean grain size of samples has been determined using SEM images that are given in Table 2.

Table 2. Mean grain size of WC-Ni composite samples.

No	Preparation Method	T_S (°C)	Mean Grain Size (μm)
1	Electroless	1000	3.44
2	Electroless	1100	3.55
3	Electroless	1200	3.92
4	Electroless	1300	5.18

4. RESULTS

By using Tables 1, we have plotted ultrasonic attenuation-different sintered temperature graph which is given in Figure 2.

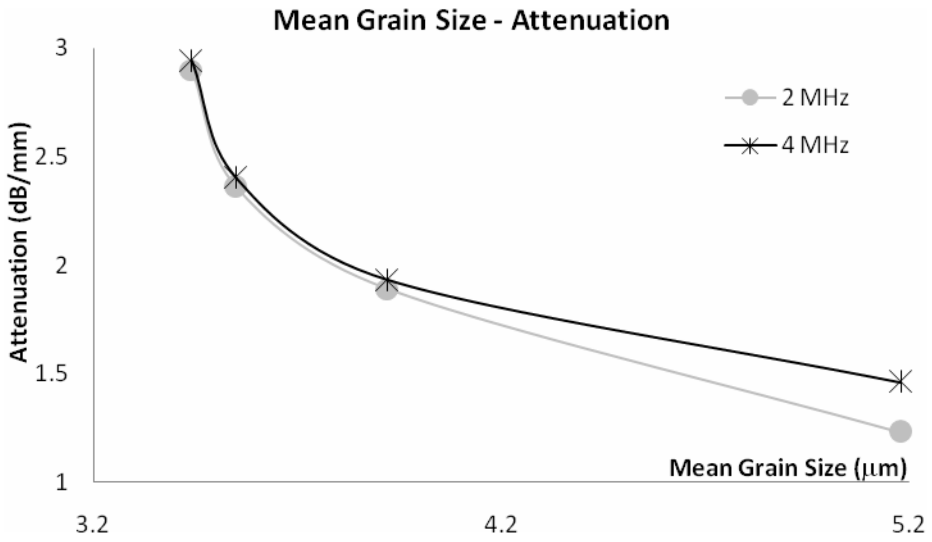

Fig. 2. Attenuation-Mean Grain Size Graph

5. CONCLUSION

This study is designed to determine the relationship between the mean grain size of some carbide based metal-ceramic composites and the ultrasonic method at sintered temperature.

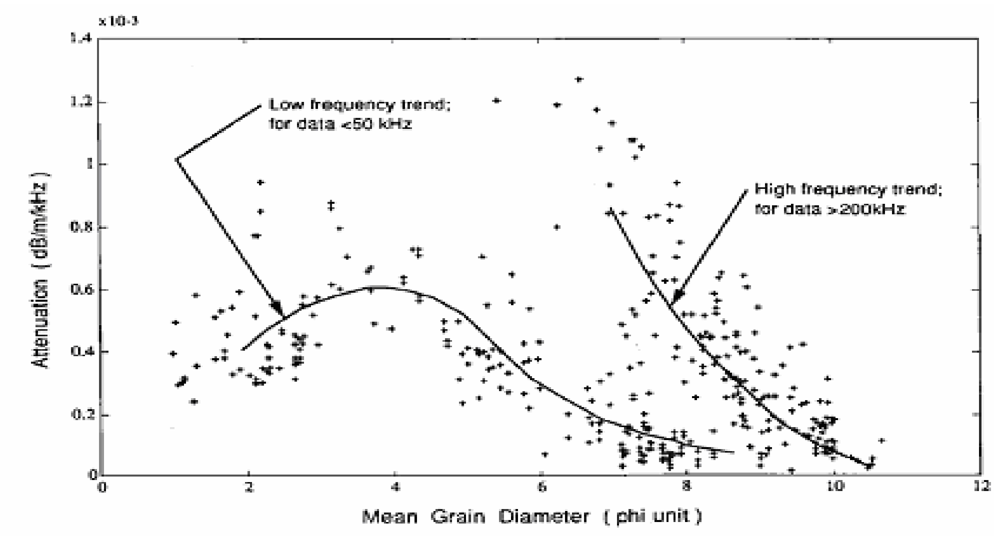

Fig. 3. Attenuation measurements for sediments with various mean grain sizes [7].

We see that according to Fig. 3, LeBlanc, Panda and Schock's works is in the high frequency region, mean grain size-attenuation graphic which is harmonious with our graphic.

$$\frac{\overline{D_2}}{\overline{D_1}} = \frac{f_1}{f_2} = \frac{\alpha_1}{\alpha_2} \qquad (2)$$

According to Rooney's equation relation, which is applicable to mean grain size determination, between mean grain size and attenuation, there is inverse ratio [8]. We observed that the same result at our experiments. As a consequence, it is observed that mean grain sizes increase depending on the sintered temperature and when we look at seen in the graphic that attenuation values decrease in accordance with both the mean grain size and the sintered temperature.

6. ACKNOWLEDGEMENTS

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