Ultrasonic Dimensional Processing Of Hard And Brittle Materials (Graphite Articles)

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***Abstract* – The article is devoted to ultrasonic method of dimensional processing of hard and brittle materials as a graphite widely applied at industry in form of various wares due to its unique features.**

***Index terms* - Ultrasonic equipment, ultrasonic dimensional processing of hard and brittle materials.**

I. INTRODUCTION

GRAPHITE IS AN uncombined carbon, which is characterized by certain crystal structure, having specific composition.

Graphite articles are used in industry due to unique properties of this material such as high values of electric conductivity and heat conductivity, diamagnetic property, insolubility, elasticity, unique optic and sliding properties.

There are some problems in processing of graphite articles (see Fig.1), which prevent from wide spreading of this method at modern productions. The performing of slots and holes, which are necessary for holding and application of the articles, is a complex technical task because of extreme brittleness of the material.

Fig. 1. Example of the graphite article

At present the most common method used for graphite processing is a drilling by a diamond-containing rotating tool. Unfortunately this method lets perform only round through holes and it is characterized by low productivity and high power-consuming of the process.

That is why, it is an important task to develop and apply in practice graphite processing excluding damaging mechanical effect and providing the performance of through and blind holes of any form.

Among various methods of processing of brittle materials the ultrasonic dimensional processing is well-known [1]. The application of high-intensity ultrasonic vibrations provides performance of through and blind holes of any form, slots in such brittle materials as ceramics, glass, semi-precious stones, ferrites, etc.

II. PROBLEM DEFINITION

The ultrasonic method of processing is a sort of processing by slotting – brittle material is put out the article by hits of grains of harder abrasive, which are directed by the end of the working tool vibrating with ultrasonic frequency.

The advantages of the ultrasonic method of processing among the others are possibility to process nonconductivity and non-transparent materials, the absence of residual stress after processing leading to crack formation on processed surface at the application of other methods.

The method of ultrasonic processing is used for the graphite articles.

The test of functionability of ultrasonic processing of graphite is carried out by the ultrasonic apparatus of “Sapphire” series, model SUZ-0.4/22-O produced by “Center of Ultrasonic Technologies of Altay State Technical University” ltd, which is able to perform holes with the diameter of 1.5 upto 50 mm, with the processing speed of upto 5 mm/min (for glass).

The technology of processing is following: abrasive slurry is delivered to the operation zone, i.e. to the space between the end of the working tool vibrating at high frequency and the surface of processed article. The grains of the abrasive hit the surface of processed article under the action of vibrating tool and destroy it.

With the application of this equipment through holes with the diameters of 5, 10 and 12 mm were performed (see Fig.2). The slot on the end surface was made by the tool with the diameter of 12 mm.

Fig. 2. Appearance of the ultrasonic apparatus

In all experiments we use abrasive slurry consisting of water and silicon carbide in the ratio of 10/1 uninterruptedly supplied by the brush to the drilling zone.

The results of dimensional processing of graphite article are shown in Fig.3.

Fig. 3. Article after dimensional processing

At carrying out the experiments and adjustment of the technology of hole performance in graphite articles maximum vibration amplitude of ultrasonic influence was increased from 10 upto 60 μm. We obtained high-quality holes from the side of drilling surface. However as the amplitude and drilling speed were increased at the exit of the tool out of the material, small cleavages appeared on the graphite sample (see Fig.4).

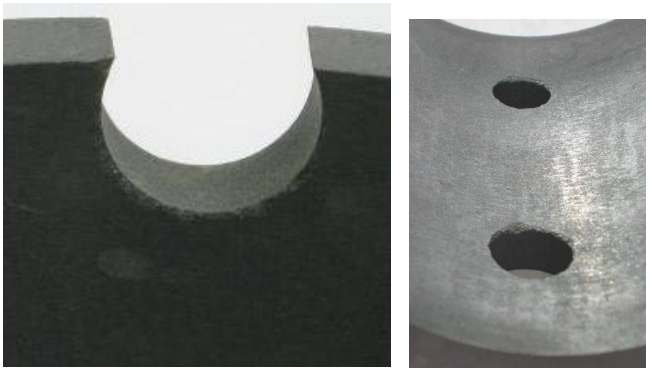

Fig. 4. Holes in graphite samples with small cleavages

To provide high-quality holes in the graphite articles the vibration amplitude of the working tool was experimentally selected, it was about 35 μm. The samples obtained at the performing of holes with specified vibration amplitude are shown in Fig.5.

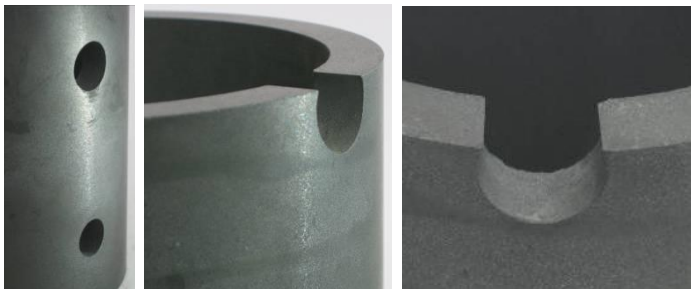

Fig. 5. High-quality holes in graphite sample

As it is evident from the photo, the holes obtained by the method of ultrasonic drilling do not have any cleavages, which can be usually formed at the exit of the tool at the use of other methods of processing.

As a result of hole drilling in the graphite articles by the working tool with optimum vibration amplitude of the working tool (35 μm) depending on the diameter of the working tool mean speed of hole drilling was no less than 1 mm/min.

To prove the possibilities of ultrasonic method of graphite processing we performed the slots of complex shape.

Fig.6 shows the example of the slot of complex form processed without drilling.

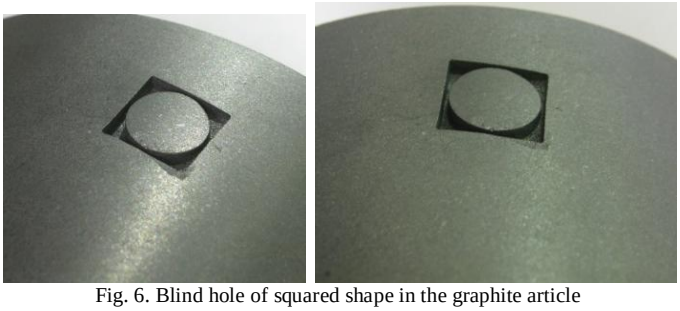

Fig. 6. Blind hole of squared shape in the graphite article

III. CONCLUSION

Thus as a result of carried out researches the possibility and efficiency of application of ultrasonic method for processing graphite articles were shown, the technology of performance of high-quality blind and through holes of various forms in the

graphite articles made by standard ultrasonic equipment was chosen and worked through, optimum amplitude of ultrasonic influence was determined. The technology and equipment can be recommended for practical industrial application.

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