Investigation of the Remote Detector Experiments on the Gorbunov Effect

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Abstract— *Investigations of the effect Gorbunova possible to determine the localization of the defect contactless microwave sensor from a distance of 70-180 mm. the possibility of indexing latent defect by comparing results before and after heating.*

Keywords— Microwave imaging method non-destructive testing of metals, the «Gorbunov» effect reactivation of samples, the indication of defects in the metal.

I. INTRODUCTION

The problem of determination of defects in metal structures in a contactless manner through the use of a microwave sensor is relevant since as was developed a miniature, semiconductor devices, like the generator of Gunn diodes. Existing methods of inspection are divided into active (ultrasonic sensing) and passive (acoustic emission). Both methods have their advantages and disadvantages. Our group of researchers has managed to combine both methods. Develop and test remote indicator of active defects (RIAD). If the definition of apparent defects at the stage of structural failure there are two ordering methods, we study the initial stage of destruction, disorders in crystal lattices, studies of mechanical tensions inside of metals with the determination of the initial stage of destruction is just beginning. The use of the method of determination of internal defects with the help of MW until recently been controversial because of the known limitations, it was believed that this method may not reveal defects within the metal, inside of the welded joints [1]. Practice has proved that this restriction is removed when using the phenomenon discovered by our group, under the guidance of Professor V. I. Gorbunov[2]. The essence of the Gorbunov effect, discovered in 1995, lies in the fact that in the interaction of weak ultrasound (less than 20 W/cm2), with dangerous defects in the metal formed during the acts of acoustic emission, is the appearance of a variable electrical surface conductivity. The interaction of the ultrasound with the defect ranging from ten minutes to hundreds of hours. The use of microwave oscillations in interaction with variable surface conductivity becomes one of the new, combining active and passive methods of nondestructive testing.

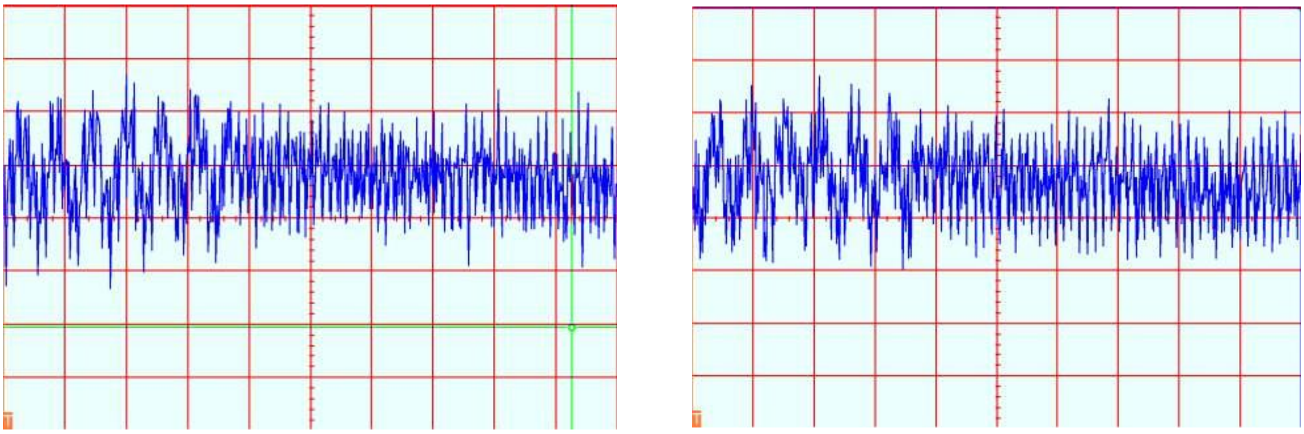
II. EXPERIMENT AND STUDY

The definition of the initial stage of destruction of metal structures is an important and challenging task. The destruction begins with disturbances in the crystal lattices inside metal with a substantial mechanical strength of the structures. To detect changes of the crystal lattices apply the complex methods used in laboratory research. The use of the method of determination of internal defects with the aid of microwave radiation, proposed by the group of Professor Gorbunov [2], is a promising direction in the diagnosis of early destruction and becomes one of the priority methods of non-destructive imaging.

The possibility of identifying defects in the lifting of loads with structures decreases with time, however, the initial stage of destruction is retained, and with increasing loads of possible catastrophic situation. To increase the activity defects in old structures used in reactivation of the structures by heating and rapid cooling [3], however, the heating and rapid cooling is often impossible or unacceptable, for example, in pipelines with asphalt or filled with oil. Also study other possibilities of reactivation, without heating and cooling. It has been suggested that the activity of defects can be restored by gamma radiation. The authors reviewed the possibilities of applying the microwave method in terms of the impact on the area of the defect in the metal x-ray radiation.

Laboratory models of remote indicator of active defects took place with the use of several types of control devices. First used the spectrum analyzer SK4-59 with a sensitivity of -110 dB/MHz, designed to control output signals of continuous operation. When using pulsed mode of operation ultrasonic generators for mechanical excitation of samples (frequencies of 40-400 KHz, amplitude 60 V - 200 V, a duty ratio of 50-200, a repetition rate of 1-2 KHz) was unable to obtain a clear image due to the lack of phase synchronization.

Then as a registered device used a digital oscilloscope firms «AKTAKOM» (ASK-3106) with analysis bandwidth up to 1000 MHz, external clock signals from the ultrasonic generator. The image of the reflected signal had a clear shape, it was possible to observe the useful signal a reactivation of the samples by heating and rapid cooling. The amplitude of the useful signal is much greater than the amplitude of noise components (the beam width in the absence of a useful signal). The result is displayed in a graphic file.



a – THE STEEL SAMPLE **b – ALUMINUM SAMPLE**

FIG.1. WAVEFORMS DURING THE OPERATION OF GAMMA RADIATION.

The scale along X =20μs.Scale Y=20 mV.

For comparison of the ability to restore the activity of the samples using gamma-radiation was used, x-ray tube with a tungsten anode, the capacity of which increased smoothly with increasing operating voltage. The image of the defects was recorded on recycled tape.

Pictures of sample of St4 steel and aluminum, given below, Fig. 2 and 3.

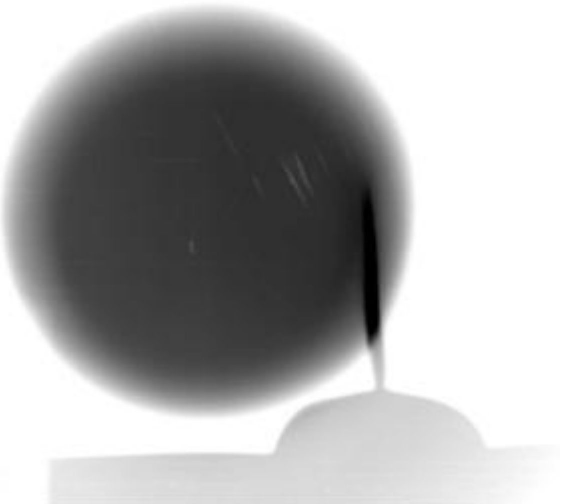


FIG.2 RADIOGRAPH OF A STEEL SAMPLE St4

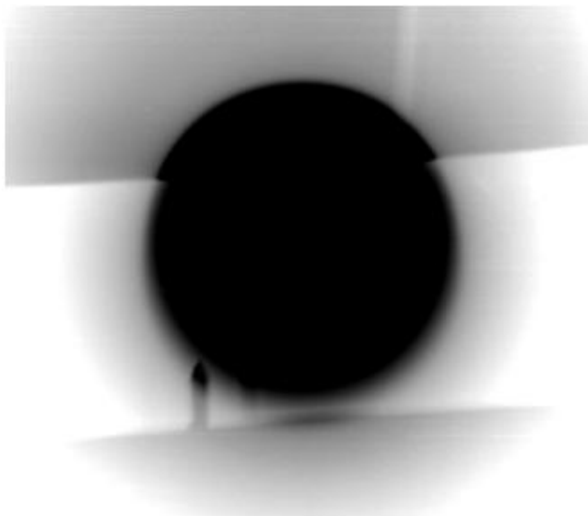


FIG.3 RADIOGRAPH OF THE ALUMINUM SAMPLE .AT BOTTOM LEFT, SHOWS THE BEGINNING OF CRACKS, THE WIDTH OF BAR 40 mm, LENGTH 250 mm, THICKNESS (DEPTH OF DRAWING) OF 20 mm., DARK SPOT IN THE CENTER OF THE MAIN BEAM

At the bottom on the right there is a grey outline of the neck of the specimen with a crack, the crack length 40-43 mm, width 3.1 mm, the end of the crack close to the middle of the sample. A dark spot in the center of the main beam.

Configuration of the microwave equipment was conducted prior to the inclusion of the generator of gamma rays. Then remotely activated the x-ray machine, used smooth increase in power with voltage regulation between 40 to 120 KV, exposure time 15 sec. A specimen with a crack were excited by ultrasound with a frequency of 48 KHz and an amplitude of

60V. The reflected microwave signal frequency of 10 GHz were recorded with the phase detector remote indicator of active defects [2]. On the oscilloscope screen observed the voltage at the output of the microwave sensor. The level of the noise signal at the phase detector output was 20 mV. Useful signal from a steel sample exceeds the noise by 5-6 dB, from aluminum sample, the ratio signal/noise was 3-4 dB. The measurement error of 1-1. 5 dB. The signal was measured before, during and after irradiation of the sample.

III. RESULT AND CONCLUSION

The useful signal recorded by the oscilloscope, the form of which is shown in Fig. 1 does not change its value in all ranges of capacity with on and off of the gamma radiation source. As a result of experiments failed to record the presence or absence of reaction of the samples to gamma radiation at different power and directions of radiation on the crack and on the part of the sample exposed to the microwave field frequency of 10 GHz.

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