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Introducing the ECNI-II

In-line Eddy Current Non-Destructive Inspection by Sintokogio

1. INTRODUCTION

Special processes such as heat treatment, painting, and welding are difficult to visually inspect. Shot peening (SP) is one of these special processes. SP is a dry method of surface modification. SP improves the fatigue strength by inducing compressive residual stress on the surface of the metal to be processed. Therefore, it is important to measure the compressive residual stress.

Until now, the quality control of the products in the SP processing line has not been performed, but only the process control of the processing machine has been performed. On the other hand, residual stress measurement after the process has been done off-line, if necessary. Generally, the X-ray diffraction method is used for stress measurement of metallic materials; the penetration depth of X-rays is a few micrometers from the top surface. If the stress in the depth direction is needed, it is necessary to measure it step by step by electropolishing. This results in the destruction of the product. Thus, it is a spot check. Therefore, there is a need for a non-destructive method to inspect the compressive residual stress in the depth direction applied by SP.

The inspection unit integrated into the processing machine in the production plant should be established by the processing machine manufacturer who knows the process well. Therefore, we have been developing a system that can perform non-destructive total inspection on SP machines. In this paper, we introduce one of the developed products, the eddy current non-destructive inspection system ECNI-II (Fig. 1).

2. ECNI-II MEASUREMENT PRINCIPLE AND FEATURES

ECNI-II is an inspection system using the eddy current measurement method. Fig. 2 shows an image of the eddy current measurement method. By applying AC magnetism to the specimen, eddy currents are generated on the surface of the specimen. The magnetic field created by these eddy currents changes the current flowing in the coil. The method to measure this change as an impedance change is called the eddy current method. The eddy current changes depending on the magnetic permeability of the specimen. Since the magnetic permeability changes due to elastic strain, plastic strain, phase transformation of austenite, etc., it is possible to inspect surface processing in which the magnetic permeability of the specimen changes.

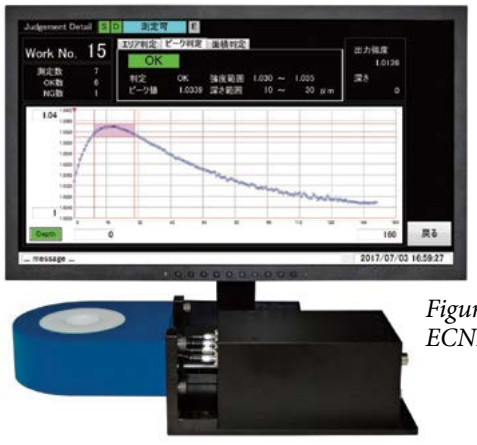

Figure 1. ECNI-II

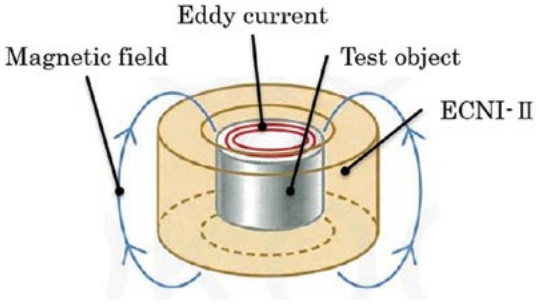

Figure 2. Eddy current method

The depth of eddy current penetration can be changed from 0 μm to approximately 200 μm by changing the excitation frequency of the coil. ECNI-II has a function to graph the processing state inside the specimen by changing the frequency and penetrating eddy currents step by step. This makes it possible to obtain inspection results from the surface to the inside of the specimen at the same time. The measurement results of ECNI-II are shown in Fig. 3. The measurement results of ECNI-II are displayed in a graph. The vertical axis shows the ratio of the eddy current reaction after

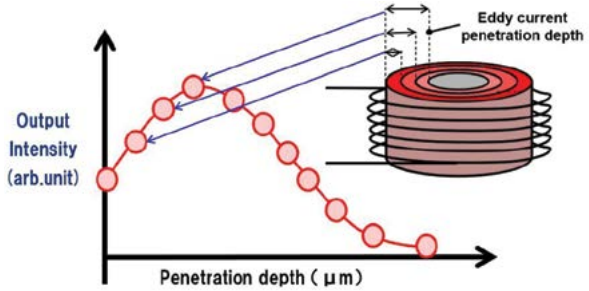

Figure 3. Measurement result

SP to that before SP. The horizontal axis shows the depth of eddy current penetration. The tick width of the measurement can be set to at least every 1 μm.

The measurement result is judged as OK or NG (No Good) by the method of area, peak, and area (Figures 4 A, B, C). After SP, a curve is drawn as shown in Fig. 3. An optimal judgment method is selected for each waveform, and a suitable threshold value is set.

The inspection time from measurement to judgment is as short as one second. These features enable nondestructive inspection of the entire inside of the processed product in the production line.

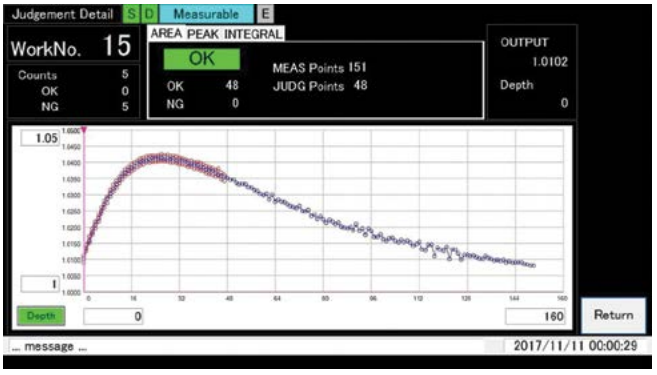

Figure 4 A. Area judgment

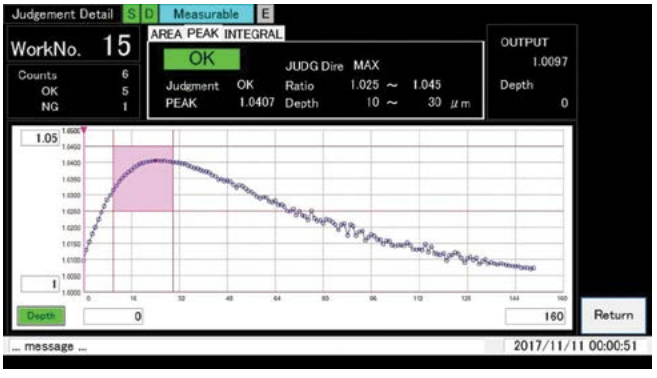

Figure 4 B. Peak judgment

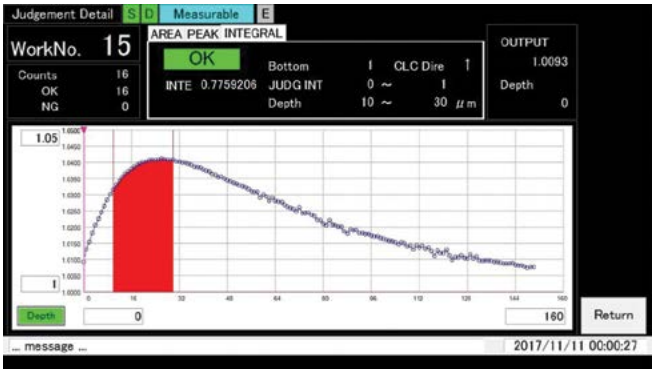

Figure 4 C - Integral judgment

3. ECNI-II MEASUREMENT EXAMPLE

In this paper, we present an example of the evaluation of carburized SCM420H, a typical gear steel, by ECNI-II. In this case, among the SP conditions, only the diameter of the peening media was changed. The measurement results are shown in Fig. 5. As the peening media diameter increased, the eddy currents were distributed from the surface to the deeper position. This is due to the change in permeability caused by the processing-induced martensitic transformation of the austenite retained by the carburizing treatment.

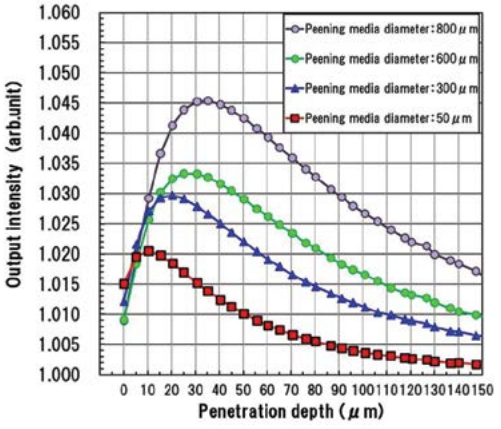

Figure 5. Measurement sample

4. CONCLUSION

In this paper, the functions of ECNI-II are explained and examples of evaluation of materials after SP are introduced. In addition to the examples introduced in this paper, the evaluation of heat treatment and material identification were also performed. We have our own experimental unit, so please contact us if you have any issues about evaluation after surface processing.