Analysis of Expert Skills on Handheld Grinding Work for Metallographic Sample

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Abstract. Most common heat treatment process for hardening ferrous alloy is known as carburizing. The quality assurance of carburizing process requires metallographic analysis of case depth, retained austenite, intergranular oxidation, and carbide network by means of metallographic sample. Metallographic preparation consists of sectioning, mounting, plane grinding, polishing to mirror surface, and etching. It is difficult for non-expert to prepare metallographic sample with global mirror surface because preparation skill needs long time experience in this field. There is no study on expert skills in preparation of metallographic samples. In this study, the difference of handheld plane grinding motion of metallographic specimen between expert and non-expert execution was analyzed. For this clarification, an electromyogram (EMG) of the muscle activities between expert and non-expert were investigated. As a result of investigation, we found the clear difference in the muscle activities of triceps, flexor digitorum superficialis, and abductor pollicis brevis between expert and other subjects.

Keywords: grinding, polishing, emg, metallographic preparation.

1 Introduction

Carburizing increases strength and wear resistance by diffusing carbon into the surface of the steel creating a substantially lesser hardness in the core. This treatment is applied to low carbon steels after machining. Usually one or more test specimens used for quality assurance accompany with the heat treatment lot. The quality assurance of carburizing process requires metallographic analysis of case depth, retained austenite, intergranular oxidation, and carbide network with an optical microscope at x 100-1000 magnification by means of the metallographic mounted sample made by the above test specimen.

The preparation process of such metallographic mounted sample is very important for the quality assurance of carburizing process. If the sample edge rounded during the preparation, accurate microstructural information needed for subsurface inspection...
cannot be obtained. Then, it leads the wasting time and money because the re-preparation of metallographic sample is required.

Fig. 1 shows the preparation process of metallographic sample. First, a section is cut perpendicularly from the surface measurement location of the specimen. Second, the obtained specimen was hot-mounted with epoxy resin and then ground by SiC coarse papers with hand to acquire plane surface. Step-wise grinding was then performed in order to produce a flat surface, followed by refined abrasive polishing, to obtain a mirror finish surface by semi-automated polishing machine.

![Fig. 1. Preparation process for metallographic sample](image)

The process for the grinding and polishing process is standardized [1]. Polishing techniques for the thermal spray coating is analyzed [2]. Many techniques for polishing process of metallographic process is contained in the technical documents [3-4]. However, most studies have not focused on the expert skills of grinding and polishing process. In fact, the surface finish of metallographic sample differs between expert and non-expert preparation. The resulting measurements of the surface roughness for ground surfaces are shown in Figure 2. Measurements were performed by Surface measurement equipment (Tokyo seimitsu, SJ-301). Rt is Sum of height of the largest profile valley Rv within an evaluation length. The mean of Rt on each gear teeth by the expert was better than that by the non-expert 1, non-expert 2, and beginner. The deviation of Rt by the expert was also better than that by the non-expert 1, non-expert 2, and beginner.

The ground surfaces of the specimen prepared by the expert were more horizontal and more uniform in roughness, making them more ideal. This quantitatively verified the expert’s superior grinding technique, although his skill has been well known to his colleagues for some time.

For the efficient transfer of the skills from expert to non-expert, it is necessary to compare and clarify the difference between the expert and non-expert execution. Comparison of the motion between expert and non-expert is commonly used for the development program for beginner and non-expert.