Effects of Grit Size Variation on the Microhardness Property of Selected Metals.

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ABSTRACT

The study of the effect of grit sizes of grinding papers on the hardness property of some selected metals was studied. A microhardness tester was used to evaluate and characterize the hardness property of some selected metals. The hardness reading was taken at every stage of grinding. Also, the microstructural evaluation was done to study the morphological view of the surface after each stage of grinding. From the results, a direct relationship between the hardness and the morphology of the ferrous metals was observed while an inverse relationship was observed in the non-ferrous metals.

(Keywords: grinding papers, microhardness, morphological view, hardness, ferrous, non-ferrous metals)

INTRODUCTION

Surface grinding is the most common of the grinding operations. It is a finishing process that uses a rotating wheel with attached abrasive to smooth the flat surface of metallic or nonmetallic materials to give them a more refined look or to attain a desired surface for a functional purpose. Typical workpiece materials include cast iron and mild steel. These two materials don't tend to clog the grinding wheel while being processed. Non-ferrous metallic materials can also be a very good workpiece. The grinding wheel is not limited to a cylindrical shape and can have a myriad of options that are useful in transferring different geometries to the object being worked on.

Sir Isaac Newton observed that scratch size decreases as abrasive size is decreased [1]. By using very fine grain abrasives, he noted, it is possible to continually fret and wear away the glass and produce a polished surface on which the scratches become too small to be visible. Along the line of this hypothesis, Lord Rayleigh found that the polishing process produces highly reflective, structure-less facets in a discontinuous fashion [4]. Further polishing does not improve the quality of the facets but extends their boundary. He suggested that the difference between polishing and grinding can occur by changing the character of the backing without altering the grit size. Later research showed that polishing and grinding are not fundamentally different [3].

Another line of research suggested that polishing is the result of surface melting [5, 6]. Proposed by Beilby and developed by Bowden and Hughes, this hypothesis states that the asperities on the surface might reach melting temperature during contact rubbing which is even more pronounced in ceramics [7].

In addition to the abrasion and melting mechanisms, adhesion was also considered as a means of material removal in polishing [8]. Because excessive energy is required to remove these high surface-to-volume ratio fragments, the surface material will be stripped off from the high spots on a molecular scale. The rate of material removal does depend, however, on the strength of the chemical bonds between molecules.

Nevertheless, the material removal rate (MRR) for various coatings is empirically found to proportionally increase with the product of applied pressure and relative velocity, which may be expressed as [2]:

$$\frac{dh}{dt} = K_p P V_R$$

Where *h* is the thickness of the layer removed, *t* the polishing time, P the nominal pressure, V_R the relative velocity, and *kp* is a constant known as the Preston constant. In the use of abrasives to remove and smoothen the top surface of a material, various grits have been device and been in used for quit an age for the grinding off of the surface of materials some of which includes metals (ferrous and non-ferrous). And the effects of grit sizes on the microhardness property of various metals are the focus of this work.

MATERIALS AND METHOD

In order to assess the effect of grits on the hardness property of metals, ferrous and non-ferrous metals are taken into consideration. Medium carbon steel (for steels) and ductile iron (for cast iron) was selected. The specimen were cut to specific configuration of $20mm^2$ tangible enough to be handled for thorough and convenient grinding and polishing. A minimum of two samples were machined for each specimen.

The cut samples were then subjected to rigorous grinding using a Buehler grinding machine. The grinding process begins with the roughest paper – i.e., grit 60 microns and subsequently changed until we get to the finest grinding paper with grit 1200 microns. At this stage, the surface of the samples was smooth enough to make any scratches on the surface disappear.

Finally, superfine polishing cloth was used to further smoothen the surface into a mirror-like structure, and at this stage every form of induced defects (scratches) were taken care of. At every stages of grinding paper used, the hardness and the surface morphology of the samples were taken and captured with aid of a microhardness tester and an optical microscope.

RESULTS

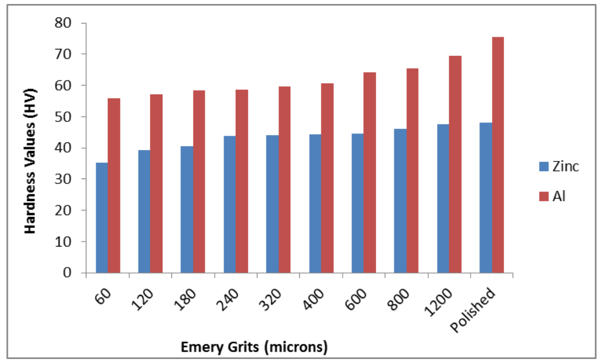

Figure 1: Effects of Variation Grits on the Hardness Property of Some Selected Non-Ferrous Metals.

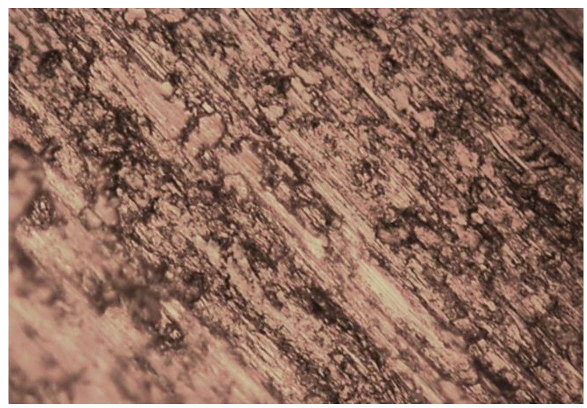

Plate 1: Photomicrograph of Aluminum after Grinding with 60 microns Paper. Mag. X200.

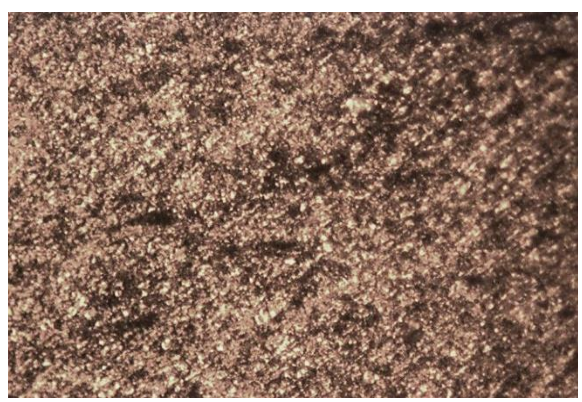

Plate 2: Photomicrograph of Aluminum after Polishing with Superfine Polishing Cloth. Mag. X200.

Plate 3: Photomicrograph of Zinc after Grinding with 60 microns Paper. Mag. X200.

Plate 5: Photomicrograph of Steel after Grinding with 60 microns Paper. Mag. X200.

Plate 4: Photomicrograph of Zinc after Polishing with Superfine Polishing Cloth. Mag. X200.

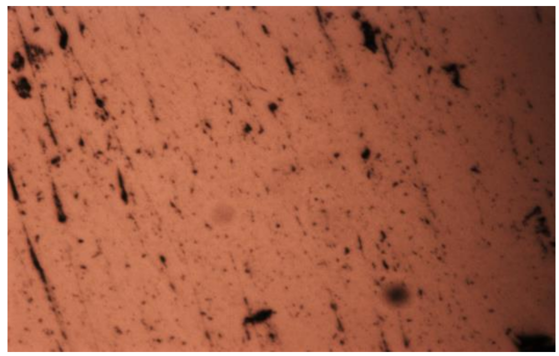

Plate 6: Photomicrograph of Steel after Polishing with Superfine Polishing Cloth. Mag. X200.

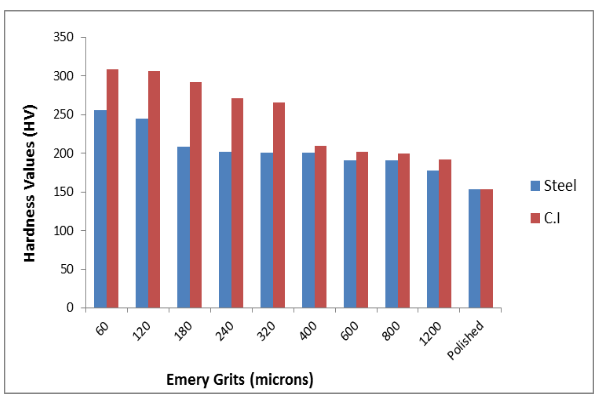

Figure 2: Effects of Variation Grits on the Hardness Property of some Selected Ferrous Metals.

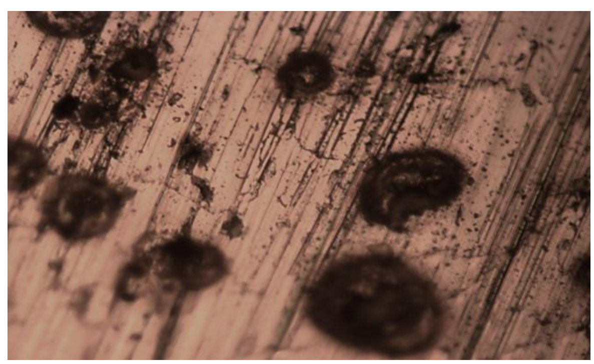

Plate 7: Photomicrograph of Cast Iron after Grinding with 60 microns Paper. Mag. X200.

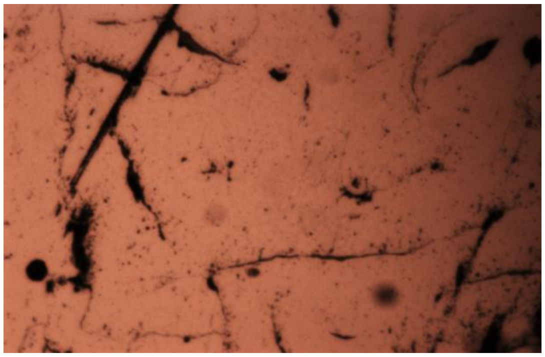

Plate 8: Photomicrograph of Cast Iron after Polishing with Superfine Polishing Cloth. Mag. X200.

DISCUSSION

The study of the effect of grit sizes of grinding papers on the hardness property of some selected metals was carried out; microhardness evaluation was used to characterize the hardness of the selected specimens at every stage of grinding. Also the microstructural evaluation was done to study the morphological view of the surface after each stage of grinding.

Figure 1 shows the effects of the variation of grits of the hardness of non-ferrous metal – aluminum and zinc has been selected for this group. From the result, it shows that there is a relationship between the sizes of the grits and the hardness property. At 60 microns grits, a very low hardness values of about 56 and 36HV was recorded for Aluminum and Zinc, respectively, while 76 and 49HV was recorded for the respective materials after the final stage of polishing with ultra-fine emery cloth.

The reason for these variations could be attributed to the zigzag morphology of the surface. In the non-ferrous samples, the peak of the zigzag shape formed on the surface of the sample will possess a lower, this is because of the direct relationship between the hardness and the total surface exposed to indentation. The reverse is however, the case in the issue of ferrous metals where the hardness and the exposed surface area of indentation, an inverse relationship is observed, thus the hardness values decreases continually until it attain a relatively consistence values at flat smooth surface.

CONCLUSION

In assessing the microhardness property of materials, the microstructure is essential for the inbuilt microscope to view, capture and evaluate the microhardness. To these effects then, these work focused on the study of the effect of grit sizes of grinding papers on the hardness property of some selected metals; microhardness evaluation was used to characterize the hardness property of the selected specimens at every stage of grinding. Also the microstructural evaluation was done to study the morphological view of the surface after each stage of grinding.

From the results, a direct relationship between the hardness and the morphology of the ferrous metals was observed while an inverse relationship was observed in the non-ferrous metals.

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