THE OXIDE INFLUENCES TOWARD THE HARDNESS OF TOOL INSERTS

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ABSTRACT

Tool inserts were generally used in the field of machining to cut steel and aluminum material. The consumer's demand the industry asked to get quality cutting tool long time use. The quality tool could reduce production costs, increase productivity since the turn of the tool is not often done. This study examined the effect of oxide $Al_2O_3 + TiO_2$ as a layer to the hardness value tool. This study used SEM to see the micro structural properties of the topography and morphology of the oxide particles. The area, the distribution and the average diameter of the particles in the PSA program analysis using Image-J. Results, topography, and morphology of the particles can determine the hardness value tool. Weight TiO_2 oxide in the coating can determine the hardness value tool. Particle size analysis has an average accuracy of 32.93% when using PSA, compared to theoretically calculate.

Keywords: SEM, image-J, PSA, microstructure, insert tools.

INTRODUCTION

The Oxide is a compound of a substance with oxygen elements, such as Al_2O_3, TiO_2, Cr_2O_3, SiO_2, Na_2O, K_2O, Ca O, Fe_2O_3, Cu O, Zn O etc. In various fields of industry material oxide compounds used as coating materials. Coated material has properties, hard, strong and resistant to corrosion. Production tool inserts are among the materials coated with oxide, such as Al_2O_3, TiO_2, Cr_2O_3, SiO_2 etc. Oxides on cutting tools are theoretically and experimentally to reduce the tendency of the steel to form cracks during the cutting process due to the temperature [1]. Oxide Al_2O_3 and TiO_2, used as a coating on cutting tool inserts due to its abrasive, hard and high melting point. The melting point is 2072 ^{0}C Al_2O_3 and 1843 ^{0}C TiO_2. Using a tool inserts coated with Tungsten carbide and oxide in [2, 3], reported that the coated cutting tool, hardness and wear resistance increase with a low friction coefficient. The coating on the tool can also function as a solid lubricant and reduce heat due to friction during the cutting process [4, 5]. In addition to coating treatment tool, to increase wear resistance could tool it is with cryogenic treatments [6, 7].

In this study, the materials used are two tool inserts are manufactured according to ISO standards TNMG160404. Carat was known the identity of the chisel (A) coated with oxide (1.08% Al_2O_3+ 98.92% TiO_2), 87.52 HRC and the chemical composition 0.56% Al, 32.86% Ti and 66.57% O. Tool (B) coated with oxide (3.05% Al_2O_3 + 96.95% TiO_2), 79.74 HRC and the chemical composition 1.58% Al, 32.02% Ti and 66.40% O.

The purpose of this study was to get the value of the area and the average diameter of the particles using Particle Size Analyze (PSA) in the Image-J program. Image-J is a program for digital image processing based on Java by Wayne Rasband of the Research Services Branch, National Institute of Mental Health, Bethesda, Maryland, USA [8]. Image-J also in the field of health and biology, used in digital image analysis [9,10]. The results of PSA compared to results of particle analysis technique from SEM images using Image-J. Assumed to be spherical particles, the area to the average (A), the average particle diameter (d) can be calculated using the equation:

$$d = 2\sqrt{\frac{A}{\pi}} \quad [\mu m] \qquad (1)$$

RESEARCH METHODS

a) Characterization SEM

a. Tool oxide inserts placed on a sample holder using carbon type, operating software VEGA application on a computer to run the SEM process.
b. Put the specimen holder containing the sample into the SEM chamber and close the chamber door. Run the vacuum pump to begin the process of vacuum in the chamber.
c. Set up the samples in the chamber in order to obtain the desired sample position and adjust the brightness and sharpness of the image on the screen.
d. After drawing the desired focus and magnification are ready, the scanning process, lock and store images.
e. The image is taken at a magnification of 500x and reference scale 5 μm.

b) Analysis of Image-J

a) Results of SEM of the microstructure of Al_2O_3 + TiO_2, prior calibration of the scale of particle size (μm) to pixel measure.
b) Calibration is done by opening the images to be analyzed and then draw a straight line along the reference size by selecting the Icon line on the Toolbar.

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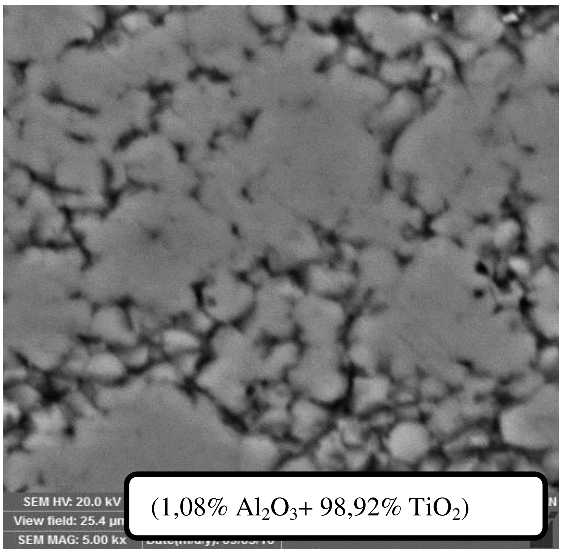
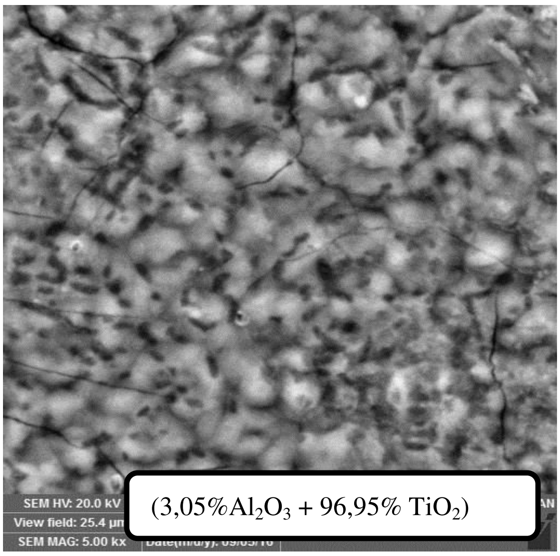
c) The Set of selected scale: Analyze > Set scale, a global checklist to use the calibration settings that are made to the Image-J closed.
d) The images in RGB format then it should be changed to 8-bit: Image > Type > 8-bit.
e) Image-J, for particle analysis, requires a definition of the image as a background section called image segmentation: Image > Adjust > Threshold.
f) Set the Threshold level to the brightness level for the definition of the object/ particle.
g) Then the measurement area of particles with a particle analysis feature in Image-J: Analyze > Set Measurements.
h) Particle Analysis: Analyze> Analyze Particle.

RESULTS AND DISCUSSIONS

Microstructure Al_2O_3 + TiO_2 tool (A) and tool (B), shown in Figure-1.



(a)

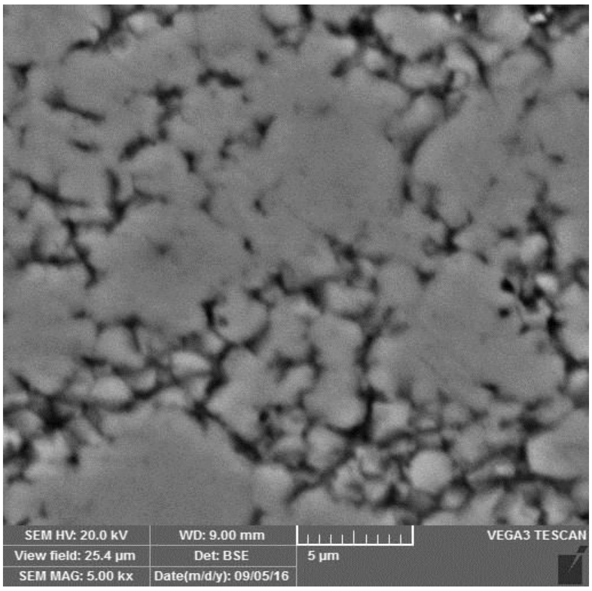


(b)

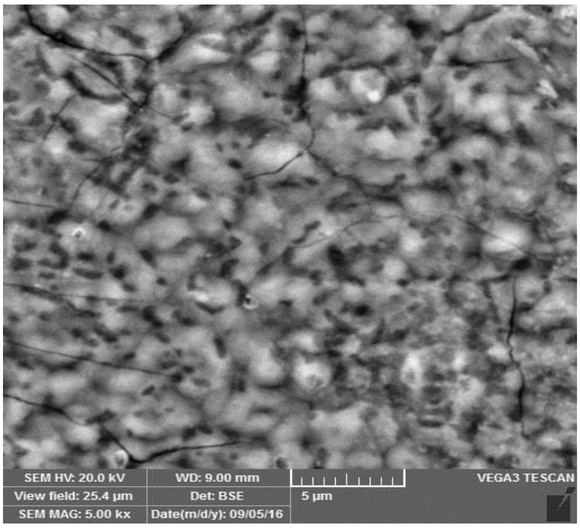
Figure-1. Microstructure: (a). tool A; (b). tool B.

Topography Figure-1 showed that the texture of the surface of the oxide layer Al_2O_3 + TiO_2 wavy or uneven, the colors bright and dark surface. The chemical composition of the oxide Al_2O_3 + TiO_2 consisting of Al, Ti, and O, if sorted according to the list of numbers of atoms, molecular weight, density in the periodic system of chemical, O: 8, Al: 13 and Ti: 22. The molecular weight, O: 15.999 g mol^{-1}, Al: 26,981 g mol^{-1} and Ti: 47,867 g mol^{-1}. Density, O: 0, 0013 g cm^{-3}, Al: 2, 7 g cm^{-3} and Ti: 4,587 g cm^{-3}. In principle constituent atoms that material with elemental atoms, atomic number, density and a higher molecular weight will reflect more electrons, so the surface looks brighter. The high surface will be more releases electrons and produces a brighter image than a low or flat surface. Weight oxide TiO_2 is more dominant than the oxide Al_2O_3 weight. The nature of the oxide Al_2O_3 and TiO_2 is resistance to very high temperatures, hard and resistant to wear caused by friction. TiO2 oxide composition which is higher in the coating can increase hardness value tool.

Morphology Figure-1, indicating the particle size varies so that the particle distribution is uneven, there are porosity and cracks. Figure-2 showed that the SEM characterization, Figure-3 after the Threshold, Figure-4 Outline of analytical results. The results of the analysis of the area and the average particle diameter are shown in Table-1.

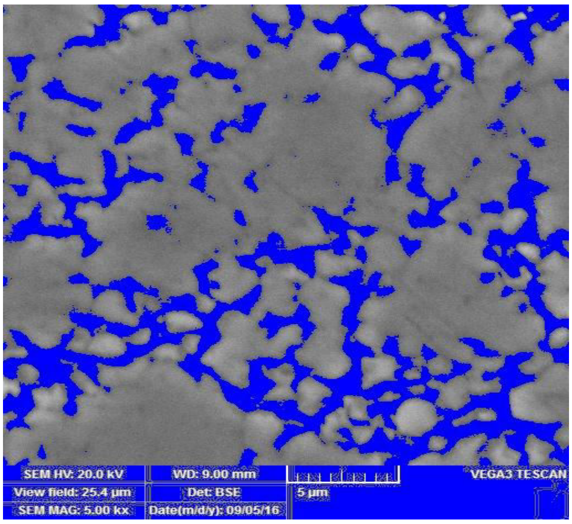


(a)

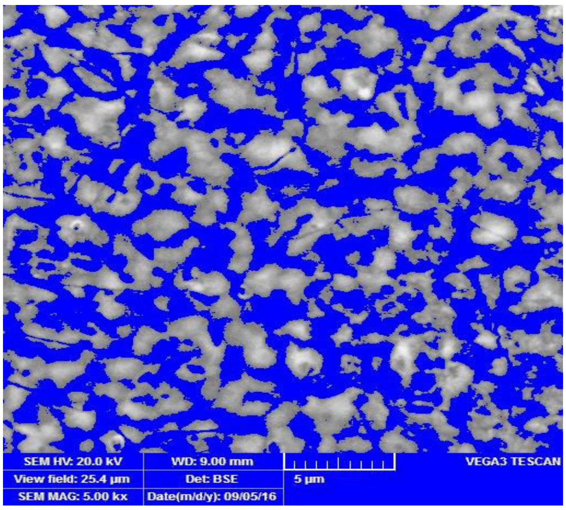


(b)

Figure-2. SEM microstructures result (unprocessed): (a). tool A; (b). tool B.

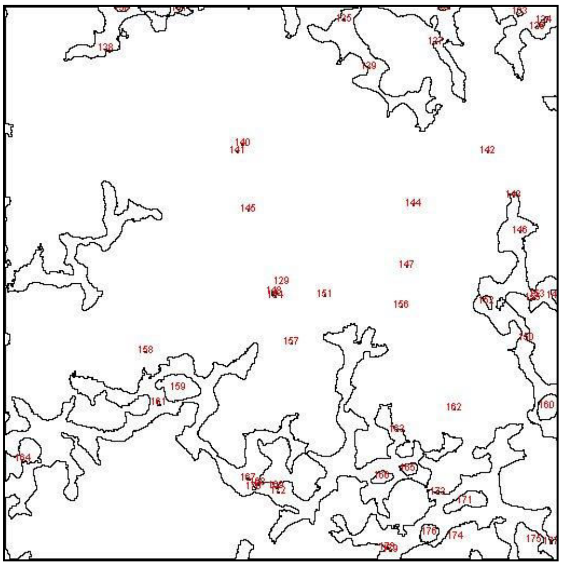


(a)

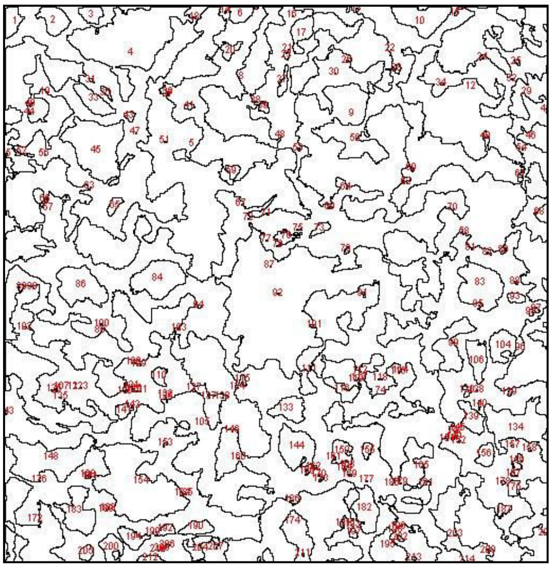


(b)

Figure-3. Results threshold: (a). tool A; (b) tool B.



(a)



(b)

Figure-4. Outline: (a). tool A; (b). tool B.

Table-1. Values particle analysis, 500x.

Numbers	Tool	Area average (μm^2)	Diameters average (µm)	Diameters PSA (µm)	Accuracy (%)
1	tool A	4,527	2,401	5,774	41,591
2	tool B	1,392	1,332	5,487	24,269
				Average	32,930

Table-1 shows, the area to the average particle tool (A) 4.527 μm^2 and tool (B) 1.392 μm^2, when using equation (1) then obtained an average value of particle diameter tool (A) 2,401 µm and tool (B) 1,332 µm. Result analysis was using PSA value of the average particle diameter tool (A) 5.774 µm and tool (B) 5.487 µm. When compared to the value of the average diameter of the particles using equation (1) and the results of the analysis of PSA, average accuracy of 32.93% using PSA analysis. The big difference in the value of accuracy due to the size and distribution of particles varies. Particles with a smaller size can expand the surface contact between the particles, the particles will be distributed evenly, the stronger bonds between the particles, porosity and crack percentage lower. Morphological characteristics of particle size oxide Al_2O_3 + TiO_2 can determine the hardness value tool. The lower the percentage value of the higher porosity and cracking tool hardness values [11].

CONCLUSIONS

a) The topography and morphology of the oxide Al_2O_3 + TiO_2 could determine the hardness value tool.

b) The composition of TiO_2 oxide in the coating can determine the hardness value tool.

c) Particle size analysis has average accuracy of 32.93% when using PSA, compared to theoretically calculated.

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REFERENCES

[1] Ahmad Yusran Aminy, Rudi Soenako, Wahyono Suprapto, Yudy Surya Irawan. 2015. A Study of Oxide Effect in Cutting Tools, toward the Cutting Tools, Wear on Cast Iron Turning. International Journal of Applied Engineering Research. 10(1): 1951-1960.

[2] D.E. Wolfe, T.J. Eden, J.K. Potter and A.p.Jaroh. 2006. Investigation and characterization of Cr_3C_2 - Based Wear-Resistant Coatings Applied by the Cold Spray Process. Journal of Thermal Spray Technology. 15(3): 400-412.

[3] G.J. Ji, C.J.Li, Y.Y.Wang and W.Y.Li. 2007. Erotic Performance of HVOF Sprayed Cr_3C_2 NiCr Coatings. Journal of thermal Spray Technology. 16(4): 557-565.

[4] Fitzsimmons M and Sarin V.K. 2001. Development of CVD WC-Co Coating. Surface Coating Technology. 137. Elsevier.

[5] Sreejitth P.S and Ngoi B.K.A. 2000. Dry Machining: Machining of the future. School of Mechanical and Production Engineering, Nanyang Technology University Singapore.

[6] Thamizhmanii S, Nagid, Sulaiman H 2011. The performance of deep cryogenically treated and non-treated PVD inserts in milling, Journal Achievements in Materials and Manufacturing Engineering, Vol.49 (2), pp 460-466.

[7] B.R.Ramji, H.N.Narasimha Murthy and M.Krishnal. 2010. Analysis of Roughness and Flank Wear in Turning Gray Cast Iron Using Cryogenically Treated Cutting Tool, Research Journal of Applied Sciences, Engineering, and Technology 2(5): Maxwell Scientific Organization, ISSN: 2040-7467, pp. 414-417.

[8] Podlahove Alexey and Eugene. A. 2003. Working and Development with Image-J: A Student Reference, Joensuu: Departement of Computer Science, University of Joensuu.

[9] Abramoff M. D., Paulo J.Magalhaes., Sunanda J.Ram. 2004. Image Processing with Image-J. Biophotonics International. 11(7): 36-42.

[10] Gerd H.Woehrle., James E. Hutchison. 2006. Analysis of Nanoparticle Transmission Electron Microscopy Data Using a Public Domain Image Processing Program, Turk J.Chem. 30: 1-13.

[11] C. J. Li, Y.Y. Wang. 2002. Effect of Particle State on the Adhesive Strength of HVOF Sprayed Metallic Coating, Journal of thermal Spray Technology. 11(4): 523-529.