ASIATRIB 2002International Conference
JEJU ISLAND, KOREA

EFFECTS OF CO CONTENT AND WC GRAIN SIZE ON WEAR OF WC CEMENTED CARBIDE

Hiroyuki Saitoh[1] , Akira Iwabuchi[2] and Tomoharu Shimizu[2]

[1]*Iwate Prefecture College of Industry*
10-3-1 Ooaza Minami-yahaba Yahaba-Town 028-3615, JAPAN
[2]*Department of Mechanical Engineering, Iwate University*
4-3-5 Ueda Morioka 020-8551, JAPAN

WC cemented carbide are used as many die material to improve abration resistance. Mechanical properties of the cemented carbide were influenced by Co content and WC grain size. In this study, effects of Co content and WC grain size of WC cemented carbide on wear were examied. We prepared 13 cemented carbides with different Co content and WC grain size. Wear test was carried out against S45C under dry condition at 98N and 232mm/s. From the results, we found that wear increased with both Co content and WC grain size. Specific wear rate was range 10^{-7}mm^3/Nm.
Keywords : Cemented carbide, Co content, WC grain size, Wear

1. INTRODUCTION

WC cemented carbide has been used widely as die materials because it has good abrasion resistance due to its high hardness. And, lead-time of the product has been short in the manufacturing industry including the die industry. Therefore, high-speed processing and non-operator processing should be necessary with such as a long time it. MQL (Minimal Quantity Lubricants) has been development from the viewpoint of environment is very much done. It becomes necessary that mechanical properties under the cutting condition where a cutting tool was severe is stability so that these high-speed processing, non-operator processing and dry processing. Mechanical properties of the cemented carbide were influenced by Co content and WC grain size. In this study, the effects of Co content and WC grain size on wear were examied.

2.EXPERIMENT APPARATUS AND METHOD

The outline of the experiment apparatus is shown in Figure1.

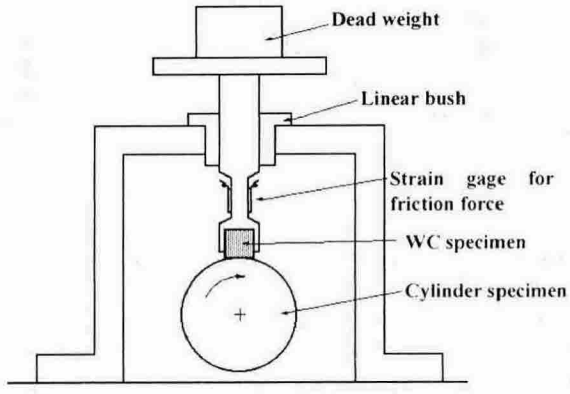


Fig. 1 Experimental apparatus

Table 1 Specimen properties

Specimen No.	Original	Vickers Hardness	Roughness(μm)		Co (wt%)		Average grain size		Specific wear rate w_s (mm^3/Nm)
			Ry	Ra	Nominal value	Actual value	Nominal value	Actual value	
1	GTi10	1647	0.62	0.046	5.7	6.41	2	2.18	0.875 10^{-7}
2	GTi20	1398	0.38	0.052	11	13.03	2	2.05	1.487 10^{-7}
3	GTi30	1228	0.54	0.048	16	16.83	2	2.43	1.919 10^{-7}
4	GTi40	1056	0.44	0.043	20	21.56	2	2.39	2.689 10^{-7}
5	GTi30S	1061	0.54	0.048	16	17.87	5	5.03	4.138 10^{-7}
6	GTi40S	949	0.38	0.052	20	14.51	5	6	5.400 10^{-7}
7	GTi50S	871	0.41	0.051	24	19.49	5	5.93	6.633 10^{-7}
8	UF30	1512	0.40	0.040	16	19.37	0.5	0.63	1.165 10^{-7}
9	Custum-1	1575	0.09	0.090	15	13.37	0.035	(0.73)	3.506 10^{-7}
10	Custum-2	1813	0.24	0.100	16	10.82	0.5	0.59	2.837 10^{-7}
11	Custum-3	1202	0.12	0.080	16	19.04	2	1.93	4.670 10^{-7}
12	Custum-4	1141	0.09	0.080	16	13.31	5	(2.23)	5.437 10^{-7}
13	Custum-5	1183	0.14	0.100	16	(5.68)	7	(4.9)	2.560 10^{-7}

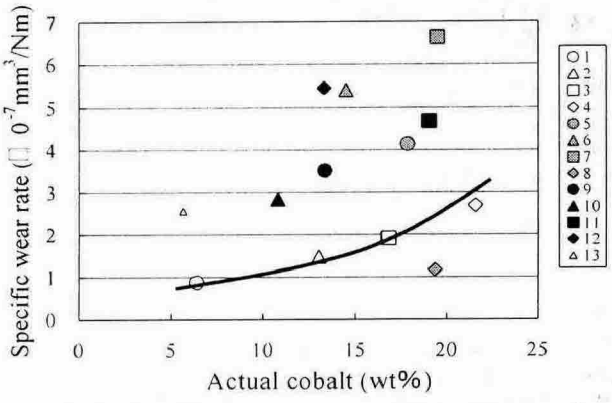


Fig.2 Specific wear rate vs actual Co(wt%)

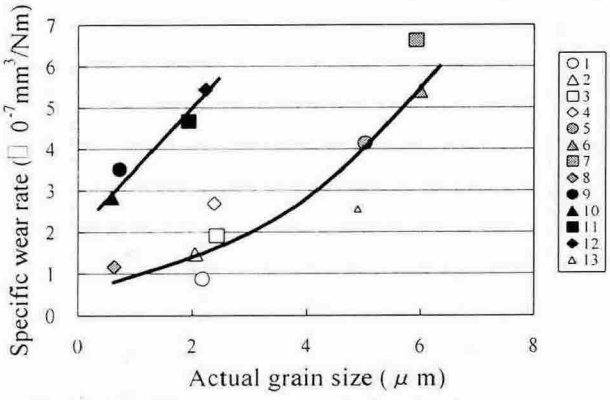


Fig.3 Specific wear rate vs actual grain size

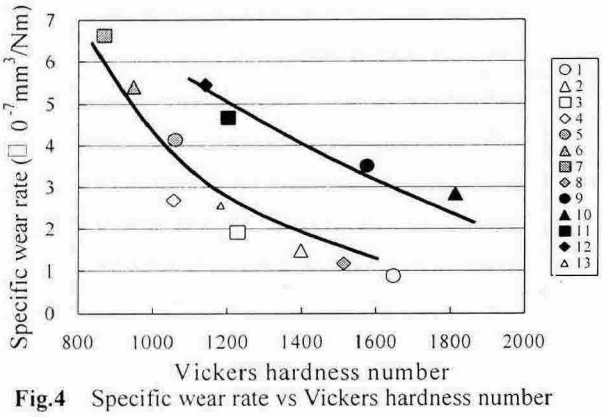
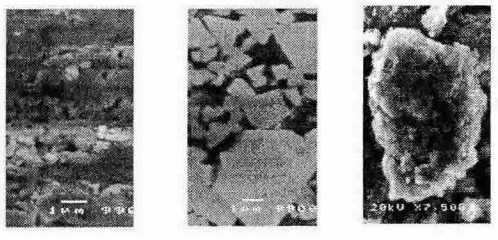


Fig.4 Specific wear rate vs Vickers hardness number



Original Surface　　Wear scar　　Wear particles

Fig.5 SEM photos (No.3)

This is block-on-cyclindar type wear test machine which a lathe was used for. Cylidrical specimen was fixed to the lathe, and rotated. A loading was a dead weight system. The strain gauge for the frictional force measurement was attached on the holder. The test specimen of WC cemented carbide is 5× 5× 10mm. And contact surface(5× 10 mm plane) was finished by the grinding of #800. 13 kinds of WC cemented carbide used are shown in Table 1. The specimens from No.1 to No.8 are in the market. Those from No.9 to No.13 are order-made. Nominally, the content of Co is varied from 5.7% to 16%, and WC grain size is from 0.035μ m to 7μ m. We measured the content of Co and grain size with SEM and EDX. Both values are shown in Table 1. Specimen No.12 has small grain size, compared with nominally value. And specimen No.13 has small Co content and small grain size, as well. Hardness test was carried out 10 times for each specimen, and the average value is shown in Table 1.

Cylidrical specimen used 0.45C carbon steel (S45C). The test was done at a load 98N, and sliding distance of 800m. A speed was 232mm/s. A frictional force was measured by the strain gauge. After an experiment was finished, it was measured with the three-dimensional contact profile meter. The worn surface of WC cemented carbide, and wear particle were observed by SEM and EDX.

3. RESULT AND DISCUSSION

3-1 Specific wear rate

Specific wear rate and the content of Co are shown in Figure 2. The specific wear rate becomes high when the content of Co increases with the same grain size. Compared with the wear of commercial materials (No.1-4), the wear of order-made materials (No.9-11) is great.

Specific wear rate and the grain size are shown in Figure 3. The specific wear rate increases with a grain size. The specific wear rate becomes high when the grain size. Compared with the wear of commercial materials (No.5-8), the wear of order-made materials (No.9-12) is great.

Specific wear rate and hardness are shown in Figure 4. Specific wear rate decrease with an increase in hardness. The wear of order-made specimens are higher than that of commercial specimens.

3-2 SEM observation and EDX analysis

SEM photographs of original surface, worn surface and wear particle are shown in Figure 5. Grinding marks were left on the original surface. Rectangular WC particles can be observed on the worn surface. Almost wear particle is from S45C. The size of spherical wear particle is about 10μ m.

4. CONCLUSIONS

We have got following conclusions.

(1)Specific wear rate was ranged in 10^{-7}mm³/Nm
(2)Specific wear rate was in proportion to the Co content
(3)Specific wear rate was in proportion to the grain size
(4)Specific wear rate was inversely proportional to hardness
(5)Specific wear rate of order-made was greater than that of market

This research was done with the NEDO consortium research and development project "Next Generation Manufacturing and Production Process of Dies" in 1998.