Brilliant Coat Cermet T1500Z for Steel Turning

Sachiko KOIKE*, Kazuhiro HIROSE, Keiichi TSUDA and Kazuo YAMAGATA

In recent years, due to the rising prices and increased use of minor metals, cermet tools that use less tungsten are in the spotlight. Coated cermet tools, used for various purposes from rough machining to finishing, need to have stable and high-quality cutting performance and a long service life. In order to meet these user needs, Sumitomo Electric Hardmetal Corporation has developed a new coated cermet T1500Z. Employing Brilliant Coat, a next-generation lubrication film, T1500Z displays superior lubrication performance and significantly reduces the reaction with iron-based metals. Consequently, T1500Z reduces cutting resistance by 30% as compared to conventional grades. T1500Z has a wide application range and contribute to processing cost reduction.

Keywords: coated cermet, PVD, turning, finishing

1. Introduction

These days, automobile and industrial machinery manufacturers are accelerating their efforts to improve processing efficiency to reduce environmental burdens, including CO_2 emissions, and processing costs. To improve the efficiency, the performance of cutting tools is extremely important. To meet customer needs for high-performance and long-life tools, new tool materials are being developed.

Meanwhile, due to the surging prices of minor metals, the use of tungsten, the main material for carbide tools, is increasingly being reduced[(1)]. Against this backdrop, cermet[*1] tools that use small amounts of tungsten have drawn attention. Since coated cermet tools are less reactive with steel than carbide tools, and have an improved fracture resistance, they are frequently used for a series of processing stages from rough machining to finishing. Therefore, coated cermet tools are strongly required to have a long service life even when used under heavy loads and produce high-quality surfaces in finishing.

In response to these market needs, Sumitomo Electric Hardmetal Corporation has developed a high-performance coated cermet tool, the Brilliant Coat Cermet T1500Z (**Photo 1**), for steel processing. This tool has a long service life and produces an excellent finishing surface.

This paper describes the features and use examples of the Brilliant Coat Cermet T1500Z.

2. Lineup of Our Cermet Grades

Figure 1 shows the lineup of our cermet grades for turning. Uncoated cermet grades T1000A and T1500A and coated cermet grades T1500Z and T3000Z can be used for all the kinds of processing from high-speed continuous processing to low-speed interrupted processing.

Generally, coated cermet is highly wear-resistant but produces a lower-quality worked surface than uncoated cermet. To overcome this challenge, we have worked on the development of T1500Z to achieve both a long service life and a high-quality surface finishing capability, thereby expanding the application range of the coated cermet tool.

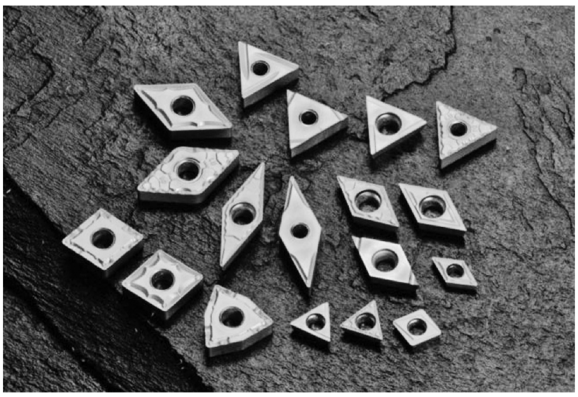


Photo 1. Brilliant Coat Cermet T1500Z

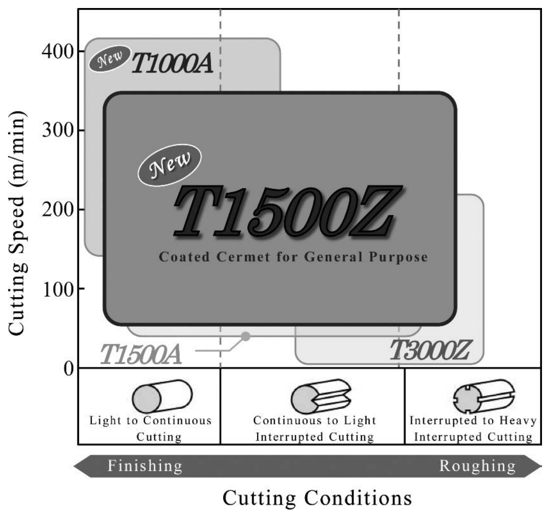


Fig. 1. Application Range of Cermet Grades

3. Features of Brilliant Coat

Figure 2 shows the damaged cutting edge of a coated cermet tool when it is used in low-carbon steel processing. The coating at the tool cutting edge is slightly chipped and has a built-up edge formed. The conventional coat is excellent in hardness and wear resistance but is brittle and subject to micro chipping. Furthermore, as it is reactive with steels, work materials tend to be welded to the tool surface. This small chipping degrades the quality of a worked surface especially in finishing, and reduces the tool life. Therefore, in the development of the Brilliant Coat, we have focused our efforts on the following two points: (i) Achieving a fine and uniform coating structure and improving chipping resistance, and (ii) Developing a coating material that has a low affinity with steel.

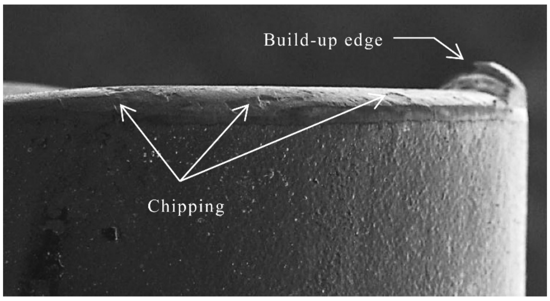


Fig. 2. Typical Damages for Coated Cermet Tool Used in Low-Carbon Steel Processing

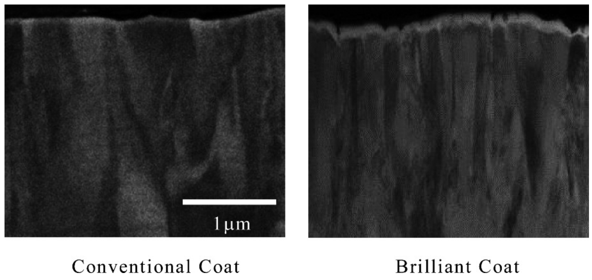


Fig. 3. Comparison of Coating Microstructures

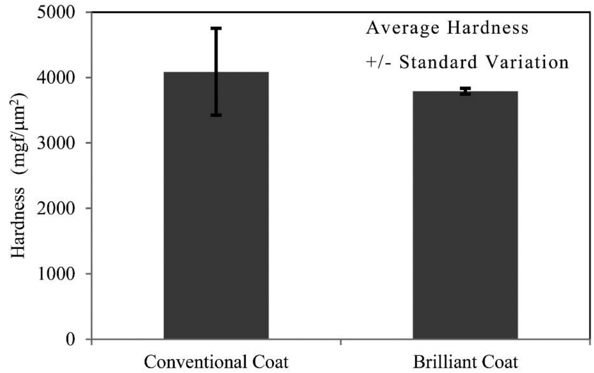


Fig. 4. Comparison of Coating Hardness

The Brilliant Coat is produced by our original Physical Vapor Deposition (PVD)*2 technique. **Figure 3** compares the sections of the conventional coat and the Brilliant Coat. The pictures show that the Brilliant Coat has a finer structure than that of the conventional coat. **Figure 4** shows the average hardness and standard variation of the conventional coat and the Brilliant Coat. It was found out that the average hardness of the Brilliant Coat is slightly lower than that of the conventional coat, but the standard variation is much smaller. This shows that the fine structure of the Brilliant Coat enables the film to have a high uniformity, minimizing the areas of low hardness where damage starts, thereby achieving high chipping resistance. As indicated by these results, we have successfully developed a highly wear-resistant and chipping-resistant film. Furthermore,

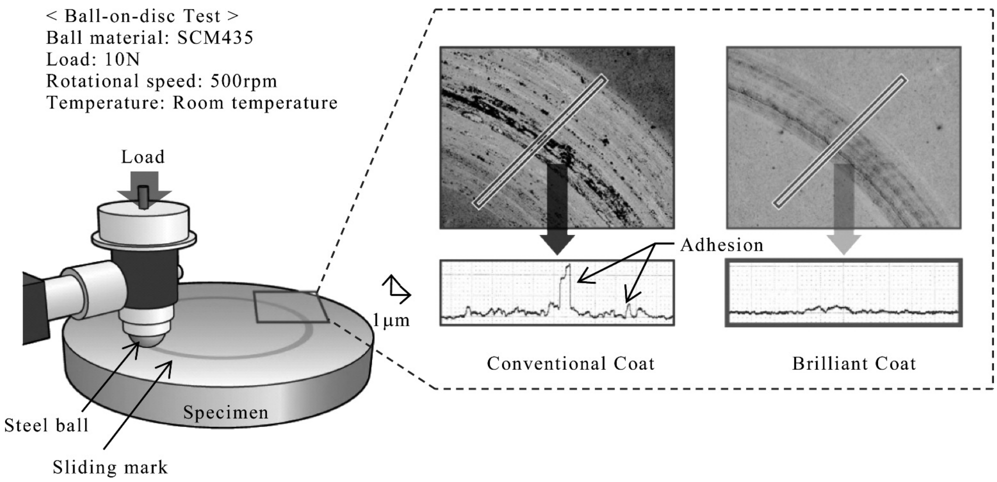


Fig. 5. Comparison of Lubrication Properties

the coat has achieved a high lubrication property and extremely low reactivity with steel through the lamination of special ceramic layers, which significantly improves the surface finishing capability of tools.

Figure 5 shows the lubrication property evaluation results of the Brilliant Coat in the ball-on-disc test. This test evaluates the lubrication properties of a film by judging how much the steel is welded to the coat surface when an SCM435 ball is slid under a load of 10 N for a specified time. As indicated by the results, the Brilliant Coat has developed much less adhesion to the steel than the conventional coat. **Figure 6** shows the cutting edge of a tool used for orthogonal cutting(2). The Brilliant Coat has developed little adhesion even at a low cutting speed of 60 m/min, and has reduced the thrust force, which is affected largely by adhesion, by more than 30%. The results of the ball-on-disc test are reproduced in actual cutting work. As indicated by these results, because the Brilliant Coat has an extremely high welding resistance to steel, it is a suitable material for cutting tools, thereby achieving a high-quality worked surface.

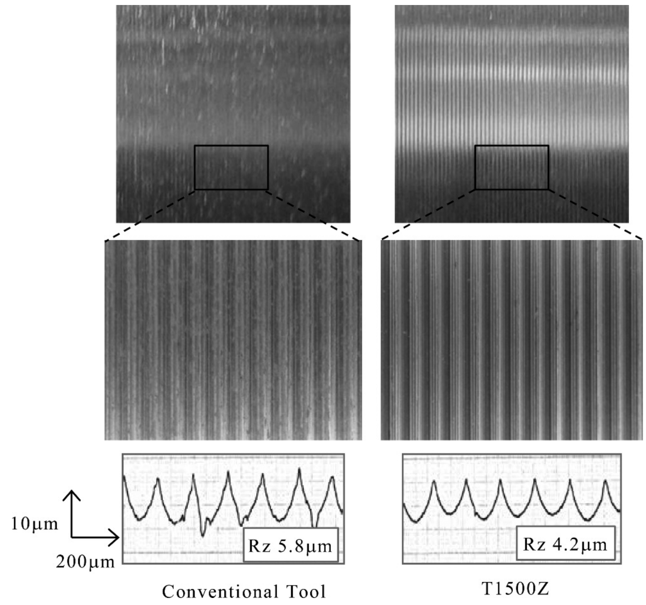


Fig. 7. Comparison of Steel Worked Surfaces
Work material: STKM13A, Insert: CNMG120408N-LU
v_c=100 m/min, f=0.15 mm/rev, a_p=1.00 mm, wet

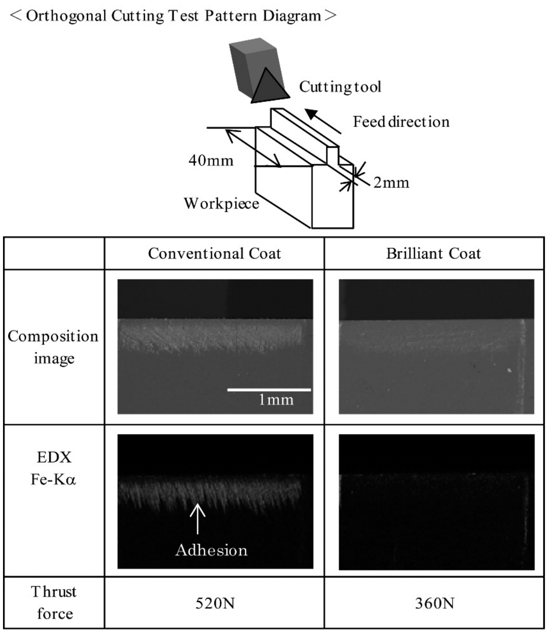


Fig. 6. Comparison of Cutting-Edge Adhesion and Thrust Force in Orthogonal Cutting Test
Work material: SCM435, Insert: TPGW160404
v_c=60 m/min, f=0.15 mm/rev, Cutting width=2.00 mm, dry

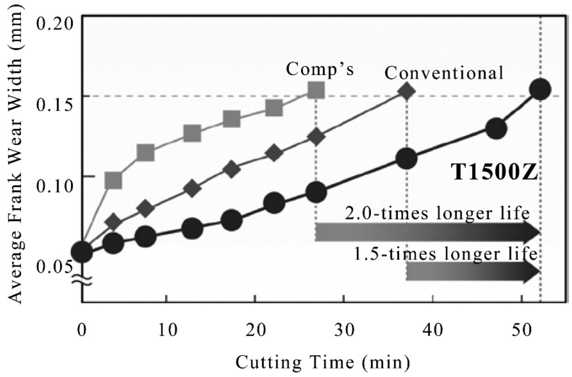


Fig. 8. Comparison of Wear Resistance
Work material: SCM435, Insert: CNMG120408N-SU
v_c=250 m/min, f=0.12 mm/rev, a_p=1.00 mm, wet

4. Performance of T1500Z

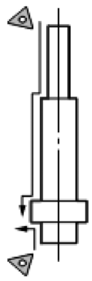
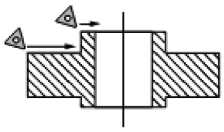
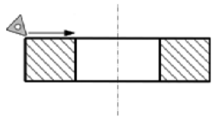
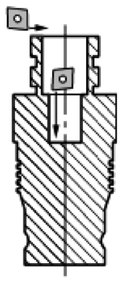
Figures 7 and 8 show the performance of the new coated cermet T1500Z, on which the Brilliant Coat is used. As expected from the lubrication property evaluation results, the new coated cermet T1500Z has less gouge-caused whitening than the conventional tool, thereby achieving an extremely fine worked surface. The roughness is sufficient and the ten-point mean roughness Rz on the worked surface is small. Furthermore, T1500Z has achieved high wear resistance, which is 1.5 times that of the conventional tool and 2 times that of a competitor's tool.

5. Use Examples

Table 1 shows use examples of the Brilliant Coat Cermet T1500Z.

Use example 1 is a case where the outer diameter of an SCM415 shaft is processed with the T1500Z tool. The reduced thrust force enables chatter marks to be reduced significantly, thereby achieving a 7.5-times longer life for

Table 1. Use Examples of T1500Z

		Use example 1	Use example 2	Use example 3	Use example 4
Workpiece shape					
Work material		SCM415	SCM420H	SCM415	S43C
Insert		TNMG160408N-SU	TNMG160408N-LU	TNGG160402R-FY	CPGT080208N-SD
Cutting conditions	Cutting speed (m/min)	220	200	200	140
	Feed rate (mm/rev)	0.26 ~ 0.34	0.15	0.07 ~ 0.15	0.15
	Depth of cut (mm)	0.20 ~ 0.25	1	0.20 ~ 0.30	0.5
	Lubrication	wet	wet	wet	wet
Results	Life of T1500Z	150 pieces/corner	1,200 pieces/corner	2,500 pieces/corner	1,700 pieces/corner
	Life of conventional tool	20 pieces/corner	600 pieces/corner	1,300 pieces/corner	600 pieces/corner
	Details	Significantly fewer chatter marks than the conventional tool. Achieved a life more than 7 times longer than the conventional tool.	Achieved a life more than twice as long as the conventional tool.	Achieved a better shine and dimensional performance on the worked surface than the conventional tool.	Achieved a better shine, dimensional performance and roughness on the worked surface, and a life more than twice as long as the conventional tool.

the tool. This comes as a result that the high welding resistance of the Brilliant Coat is brought into full play when an extremely high quality is required for the worked surface.

Use example 2 is a case where the end surface of an SCM420H automobile component is processed, whereas use example 3 is a case where the end surface of an SCM415 washer is processed. The use of T1500Z almost doubled the tool life. Use example 4 is a case where the inner diameter of an S43C lower shaft is processed. The T1500Z tool achieved better shine, dimensional performance and roughness on the worked surface than the conventional tool, while also enjoying an almost 3.0-times longer service life.

6. Conclusion

The Brilliant Coat Cermet T1500Z is a coated cermet with both a high-quality surface finishing capability and wear resistance. We are confident that the use of T1500Z will help users to improve processing quality in a wide variety of applications and reduce costs.

· Brilliant Coat is a trademark or registered trademark of Sumitomo Electric Industries, Ltd.

Technical Terms

*1 Cermet: “Cermet” is a portmanteau of “ceramic” and “metal.” It is a composite material made by mixing and sintering a titanium-based hard compound and a metallic binding material.

*2 Physical Vapor Deposition: Physical Vapor Deposition (PVD) is a physical technique used to deposit thin films on the surface of materials in the gas phase.

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Contributors (The lead author is indicated by an asterisk (*).)

S. KOIKE*

- Assistant Manager, Hard Materials Development Department, Sumitomo Electric Hardmetal Corp.

K. HIROSE

- Assistant Manager, Hard Materials Development Department, Sumitomo Electric Hardmetal Corp.

K. TSUDA

- Group Manager, Advanced Materials R&D Laboratories

K. YAMAGATA

- Director and General Manager of Development Managing Department, Sumitomo Electric Hardmetal Corp.