

Coated Cermet Grade T2100Z for Steel Turning

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In recent years, high-speed and high-productivity machining has rapidly expanded across the manufacturing industry to reduce machining costs and curb power consumption. At the same time, increasing use of rare-metal materials and rising tungsten prices have drawn attention to cermet cutting tools, which require less tungsten. Coated cermets are widely used, especially for finishing operations; however, as demands for higher speed and efficiency intensify, machining under severe cutting conditions is increasingly required. Because cermets generally have lower material strength than cemented carbide, they often lack sufficient chipping resistance in such harsh environments, leading to unstable performance and a limited application range. This paper introduces T2100Z, the latest-generation coated cermet grade developed to overcome these limitations.

Keywords: cutting tool, cermet, physical vapor deposition (PVD), high-toughness substrate, replacement of cemented carbide

1. Introduction

Indexable inserts used for machining are available in a wide variety of grades, including cemented carbide. Among them, cermet*¹ tools—composites consisting of a hard phase mainly based on titanium carbonitride and a metallic binder phase—exhibit low chemical affinity with ferrous materials such as steels. Consequently, cermets can provide high-quality surfaces and have been positioned as important tool materials, particularly in finishing applications.

In recent years, the manufacturing industries such as automotive and industrial machinery have increasingly adopted high-speed and high-efficiency machining to reduce machining costs and power consumption. However, cermets generally exhibit lower bulk strength than cemented carbides; under severe cutting conditions such as high-efficiency machining, early edge fracture may occur, leading to unstable tool life. Accordingly, cermets and cemented carbide have been applied with a clear division of roles. Recently, there has been an increasing demand for improved resistance to edge fracture that enables stable machining even under high-productivity conditions.

In addition, amid concerns over volatility and uncertainty in the supply of tungsten raw materials, interest has grown in tool materials that reduce tungsten consumption, as an alternative to cemented carbide in which tungsten is a principal constituent. Because cermets are primarily based on titanium, which entails lower procurement risk, they are advantageous from the perspective of mitigating raw-material supply risk. Therefore, expanded application of cermets as tungsten-saving tool materials is anticipated.

To meet these requirements, Sumitomo Electric Industries, Ltd. has commercialized a cermet grade, T2100Z, which achieves both excellent fracture resistance and wear resistance. This paper reports the features and performance of T2100Z.

2. Development Concept of T2100Z

2-1 Positioning of Sumitomo Electric cermet grades

Figure 1 shows the application range of Sumitomo Electric's cermet grades for turning. T2100Z is positioned as a general-purpose grade with a wide application window. For high-speed continuous cutting where high surface integrity is required from the initial stage of machining, T1000A and T1500A are recommended. For low-speed cutting and applications where adhesion/built-up edge is a primary concern, T2500Z is recommended.

T2100Z maintains the excellent wear resistance and surface-finish capability of the conventional cermet grade T1500Z while significantly improving resistance to edge fracture, thereby expanding its application range. Depending on the cutting environment, T2100Z can also be applied in domains where chemical vapor deposition (CVD)*²-coated cemented carbide has conventionally been selected.

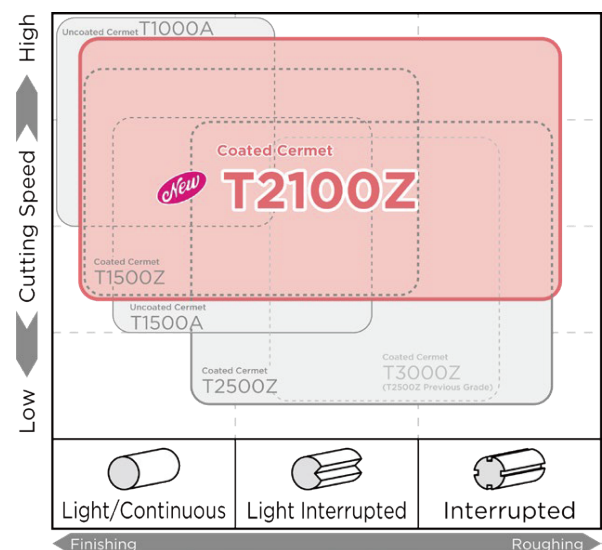


Fig. 1. Lineup of cermet grades for turning

2-2 Development targets of T2100Z

With increasing volatility in raw-material prices and uncertainty in supply, cermet tools are required not only to provide extended tool life versus conventional cermets, but also to improve tool life and surface finish versus cemented carbide. Accordingly, the development targets of T2100Z are to enhance wear resistance, resistance to edge fracture, and finishing surface integrity versus both conventional cermets and cemented carbide, through advancement of the substrate, coating technology, and edge preparation technology.

3. Features of T2100Z

T2100Z employs a dedicated high-toughness substrate and applies Sumitomo Electric's proprietary physical vapor deposition (PVD)*³ coating technology, Absotech. Figure 2 illustrates the structure of T2100Z.

Regarding the substrate, scanning electron microscope (SEM) images of the alloy microstructure of T2100Z and a conventional cermet are shown in Fig. 3.

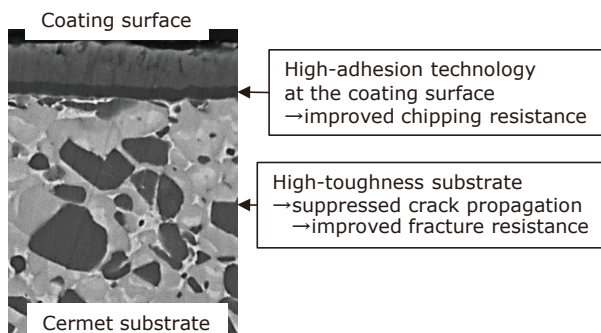


Fig. 2. Structure of T2100Z

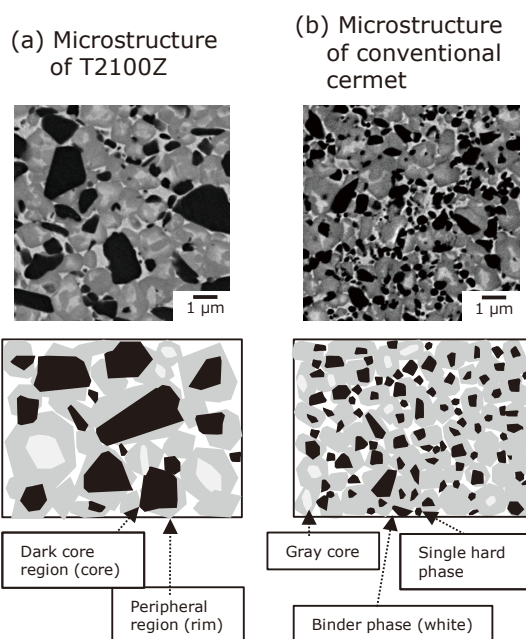


Fig. 3. Alloy microstructures of T2100Z and a conventional cermet (SEM images)

Both microstructures exhibit a “core–rim” duplex structure composed of a dark core region mainly consisting of titanium carbonitride and a surrounding rim region consisting of a solid-solution carbonitride of titanium with tungsten, niobium, and other elements. In addition, the microstructure contains multiple types of hard phases with different grain sizes and compositions: (i) fine, dark titanium carbonitride hard phase; (ii) gray hard phase consisting of solid-solution carbonitride; and (iii) hard phases with a tungsten-rich light-gray core, together with a binder phase.

As shown in Fig. 3 (a), a key feature of T2100Z is that the hard phases—including the core–rim duplex grains—are coarsened compared with those of the conventional cermet.⁽¹⁾ Whereas conventional approaches often relied on refinement of the core region or dark hard phase to improve wear resistance and toughness, T2100Z improves toughness by controlling the microstructural scale while retaining the duplex structure, thereby reducing the number of grain boundaries and complicating crack propagation paths.

In general, toughness and hardness exhibit a trade-off relationship; increasing toughness tends to reduce hardness, making it difficult to obtain sufficient wear resistance. In T2100Z, the composition and sintering conditions were optimized to enhance inter-particle bonding strength. As a result, as shown in Fig. 4, T2100Z improves toughness while maintaining the substrate hardness of the conventional cermet. This enables both high wear resistance and high fracture resistance, realizing long tool life and stable machining.

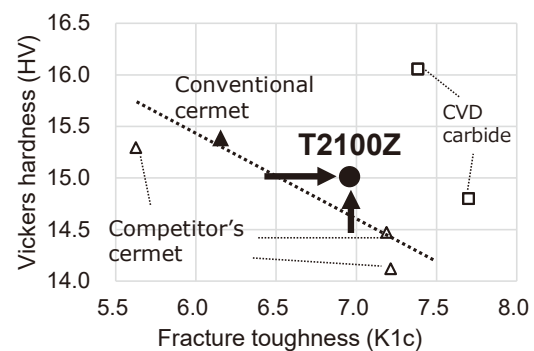


Fig. 4. Correlation between Vickers hardness and fracture toughness of T2100Z and conventional cermet

With regard to the PVD coating technology, Fig. 5 compares the coating architecture and substrate surface condition between T2100Z and a conventional cermet.⁽²⁾

While the conventional cermet employs a two-layer coating structure, T2100Z adopts a single-layer coating architecture, which suppresses edge chipping associated with coating delamination. In addition, T2100Z applies a smoothing edge treatment to the substrate to improve the surface condition, thereby enhancing coating adhesion and improving chipping resistance. Owing to the combined effect of the PVD coating and smoothing edge treatment, T2100Z achieves a significant reduction of edge chipping, as shown in Fig. 6.

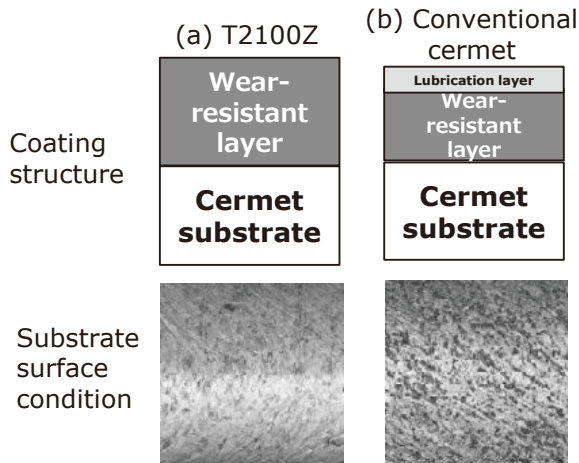


Fig. 5. Coating architecture and substrate surface condition of T2100Z and a conventional cermet

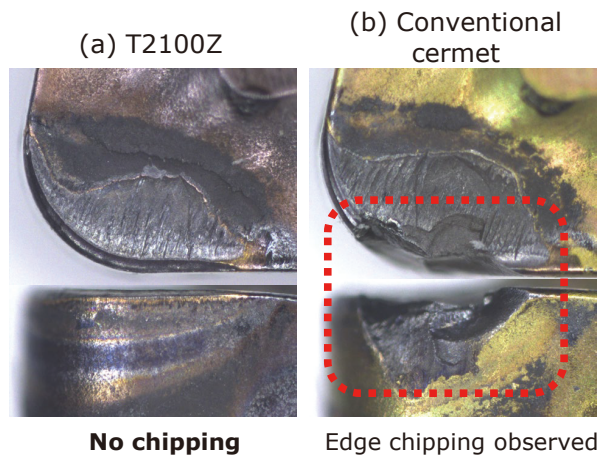


Fig. 6. Cutting-edge photographs after machining for T2100Z and a conventional cermet

4. Performance of T2100Z

Figures 7 and 8 present the turning performance of T2100Z.

Figure 7 shows the results of a fracture-resistance test in interrupted turning of alloy steel. By integrating the high-toughness substrate with the proprietary coating technology, T2100Z exhibited tool life more than 300% that of the conventional cermet. Furthermore, T2100Z demonstrated tool life comparable to that of CVD-coated cemented carbide, achieving machining stability that extends beyond the conventional application window of cermet tools in continuous to interrupted cutting.

Figure 8 shows the results of a wear-resistance test in continuous turning of alloy steel. Through optimization of composition and sintering conditions, T2100Z exhibited 150% higher wear resistance than the conventional cermet. In addition, compared with CVD-coated cemented carbide, T2100Z achieved 120% longer tool life when flank wear was the dominant failure mode.

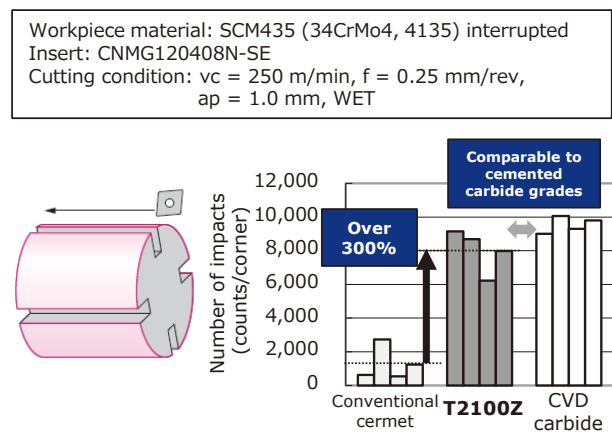


Fig. 7. T2100Z chipping resistance performance

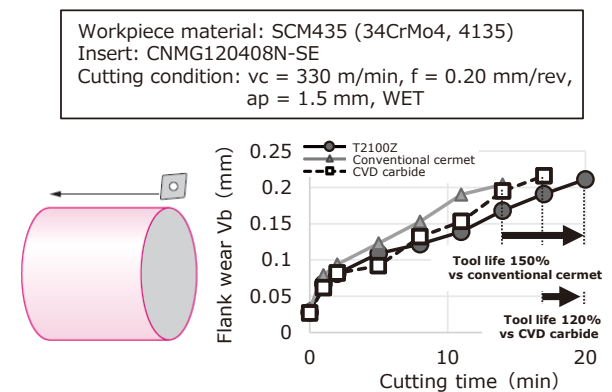


Fig. 8. T2100Z wear resistance performance

5. Application Examples of T2100Z

Application examples using T2100Z are shown in Figs. 9–12.

Figure 9 shows an example of machining an automotive component (sheet steel). Owing to its high wear resistance, T2100Z reduced flank wear compared with the conventional cermet.

Figure 10 shows an example of machining a shaft (SCM420H). Owing to its high fracture resistance, T2100Z

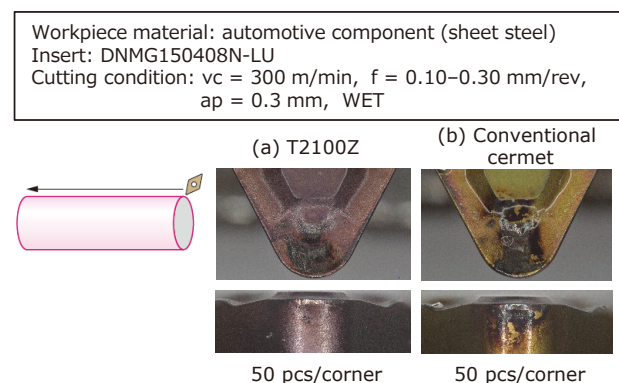


Fig. 9. Application example 1

achieved twice the tool life of the conventional cermet.

Figure 11 shows an example of machining a sun gear (SCM420). T2100Z demonstrated tool life equivalent to that of CVD carbide due to its high fracture resistance, and also reduced flank wear owing to its high wear resistance.

Figure 12 shows an example of machining a bearing (SUJ2). T2100Z demonstrated tool life equivalent to that of CVD carbide due to its high fracture resistance, and also reduced flank wear owing to its high wear resistance.

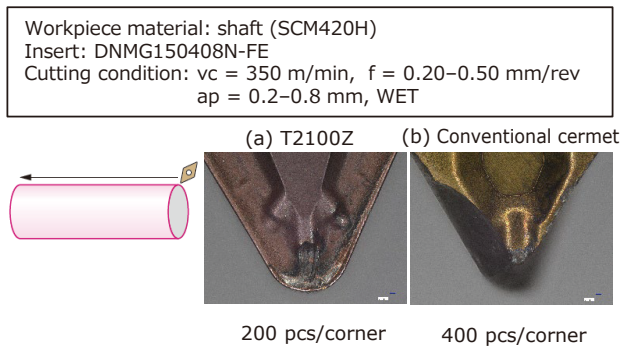


Fig. 10. Application example 2

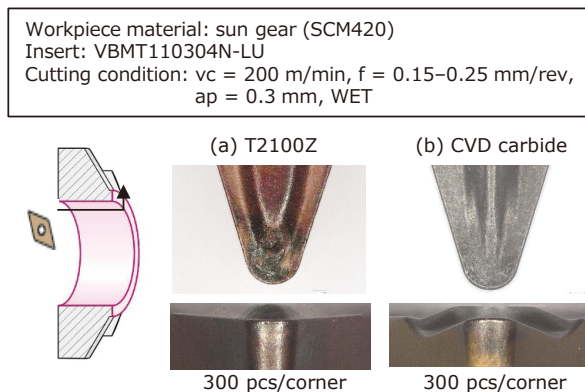


Fig. 11. Application example 3

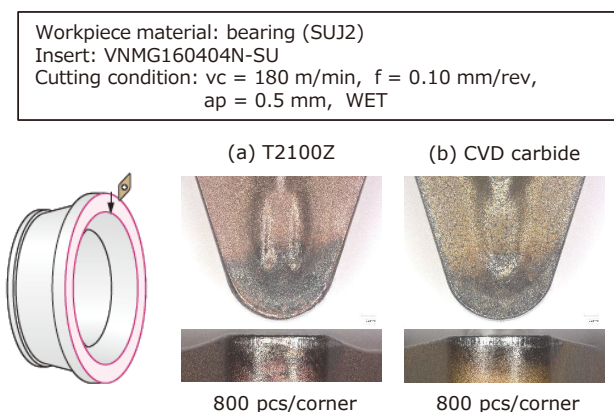


Fig. 12. Application example 4

6. Conclusion

T2100Z is a highly stable coated cermet grade that improves both fracture resistance and wear resistance compared with conventional cermets. In finishing operations, it can also deliver fracture resistance and wear resistance comparable to those of CVD-coated cemented carbide. T2100Z is expected to contribute significantly to reducing tool cost, lowering machining cost, and improving productivity for end users.

• Absotech is a trademark or registered trademark of Sumitomo Electric Industries, Ltd.

Technical Terms

- *1 Cermet: A composite material sintered from a mixture of ceramic-based (typically titanium-based hard compounds) and metallic binder constituents; the term is derived from “ceramic” and “metal.”
- *2 Chemical vapor deposition (CVD): A coating process in which a ceramic layer is formed on a substrate surface using chemical reactions.
- *3 Physical vapor deposition (PVD): A deposition process in which a target material is ionized (e.g., by arc discharge), reacted with gas, and deposited onto a substrate as a ceramic coating.

References

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