



Coated Grade AC1135U for Small, Automatic Lathe Turning

Taisei TANAKA*, Yuta SUZUKI, Nana MATSUSHITA, Takato YAMANISHI, and Susumu OKUNO

In recent years, advancements in component precision have accelerated in fields such as the automotive industry and semiconductor manufacturing equipment. As a result, the demand for tools for small, automatic lathes used to machine precision parts has been increasing year by year. In particular, the adoption of stainless steel parts—known for their excellent durability and heat resistance—is on the rise. However, when machining stainless steels with high corrosion resistance, such as SUS316L, cutting tools tend to have a shorter tool life. This leads to challenges including higher tool costs and increased replacement frequency. This article introduces AC1135U, a new grade optimized for improving machining stability, extending tool life, and enhancing the quality of machined surfaces in stainless steel machining.

Keywords: cemented carbide, PVD,*1 high precision, Swiss machine, small lathe

1. Introduction

Among the replaceable cutting insert grades used for cutting tools, grades with a hard ceramic coating applied to a cemented carbide substrate surface (hereinafter referred to as “coated grades”) have an increasing share year by year because they offer an excellent balance between wear resistance and chipping resistance compared to other tool materials. Currently, coated grades account for more than 70% of all replaceable insert grades.

In recent years, downsizing, weight reduction, and higher precision of components have advanced in fields such as the automotive industry and semiconductor manufacturing equipment. To meet the demands of micro-machining, tools with sharp geometries emphasizing cutting performance are required. On the other hand, sharp tool geometries are prone to chipping, and among coated grades, high-strength PVD*1 coated grades have become mainstream.⁽¹⁾ In terms of workpiece materials, various steels such as carbon steel, alloy steel, stainless steel, and cast iron are machined; however, demand for parts using stainless steel, which has superior corrosion and heat resistance, has been increasing year by year. Among stainless steels, SUS316L is used for parts requiring particularly high corrosion resistance. Compared with SUS304, which is also an austenitic stainless steel, SUS316L tends to cause unstable dimensional accuracy due to wear, built-up edge, and sudden chipping, requiring frequent tool changes and resulting in reduced productivity. Additionally, repeated removal and reattachment of the cutting edge cause unstable surface roughness, causing users to face difficulties in selecting cutting conditions that meet surface roughness specifications.

range of machining areas, especially for stainless steel machining. For high-speed machining conditions exceeding a cutting speed of 120 m/min, as well as medium- to high-carbon steels and high-hardness workpieces after heat treatment, Sumitomo Electric Hardmetal Corp. recommends our grades for difficult-to-machine materials, “AC5015S” and “AC5025S.”

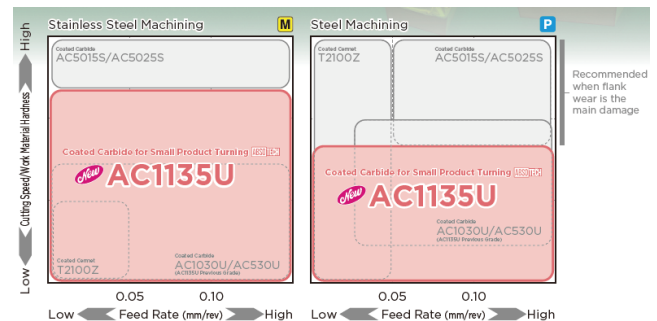


Fig. 1. Lineup of cermet grades for Swiss turning

Furthermore, for steel machining focusing on surface finish quality with a feed rate of 0.05 mm/rev or less, we suggest using the cermet grade “T2100Z,” which has low reactivity with steel.

AC1135U offers significantly improved resistance to built-up edge and chipping, enabling high dimensional stability and good surface finish quality in machining operations dominated by adhesion-type wear such as stainless steel and low carbon steel machining.

2-2 Performance targets of AC1135U

To clarify the development objectives of AC1135U, damage analysis was conducted on inserts after machining SUS316L in actual machining environments. As shown in Fig. 2, the analysis revealed that deterioration of surface roughness was caused by sudden chipping at the front

2. Development of AC1135U

2-1 Positioning of our grades

Figure 1 shows our lineup of grades for small, automatic lathe turning. AC1135U is positioned as the first recommended grade for this application and covers a wide

cutting edge boundary and cutting edge ridge, while dimensional variation was attributed to wear progression. Furthermore, cross-sectional observations of the cutting edge clarified that the attachment and detachment of adhesion played a significant role in both the sudden chipping and wear progression.

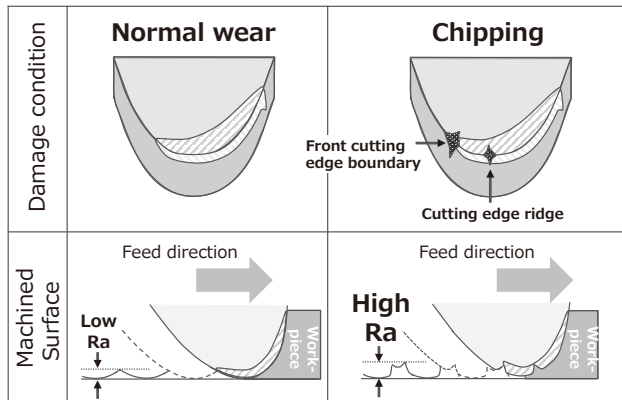


Fig. 2. Effects of chipping on machined surfaces

Specifically, as shown in Fig. 3, cracks developed within the tool coating due to cutting loads during machining, and as machining progressed, the damaged coating and substrate detached along with the adhesion.

Therefore, we focused on improving tool life in SUS316L machining with AC1135U, aiming to achieve high dimensional stability and surface finish quality by suppressing adhesive wear.

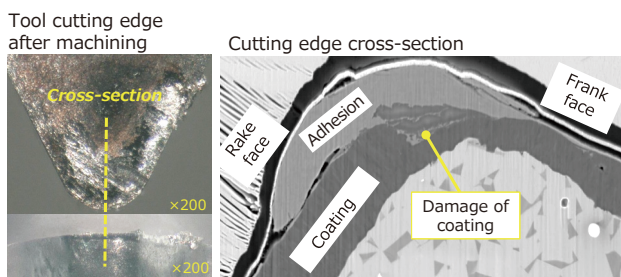


Fig. 3. Cutting edge and cross-section after machining

3. Features of AC1135U

AC1135U applies our proprietary PVD coating technology, Absotech, along with a special surface treatment. Figure 4 shows the structure of AC1135U.

The PVD coating consists of two layers: a TiCN-based coating with excellent adhesive wear resistance is applied on the upper layer, and a TiAlBN-based coating with superior crack propagation resistance is applied on the lower layer.

The TiCN-based coating has a lower coefficient of

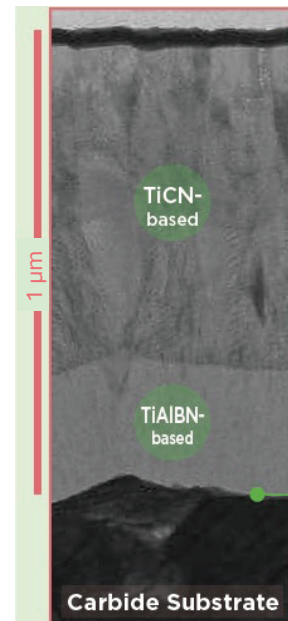


Fig. 4. Cross-sectional view of the coating

friction against stainless steel compared to conventional AlTiN-based coatings, which suppresses adhesion on the cutting edge during machining and is expected to improve dimensional stability. It also reduces the tearing of the machined surface caused by the attachment and detachment of built-up edge, enabling the maintenance of excellent surface finish quality under micro-cutting and low-speed conditions.

On the substrate side, we adopt our proprietary ultra-fine TiAlBN-based coating with boron (B) addition, which densifies the coating and provides superior crack propagation resistance. This prevents cracks generated within the coating by the attachment and detachment of adhesion from propagating into the substrate, thereby suppressing sudden chipping and enhancing machining stability. At the interface between the coating and substrate, we adopt our proprietary high-adhesion technology offering excellent chipping resistance, significantly reducing film chipping. Regarding coating thickness, while conventional PVD coatings for precision machining typically have a total thickness around 2 μm , AC1135U adopts a very thin design with a total thickness of 1 μm . This 1 μm thickness improves cutting edge sharpness and reduces edge load, thereby suppressing adhesion and sudden chipping.

Additionally, as shown in Fig. 5, the special surface treatment newly applied in this product creates a glossy

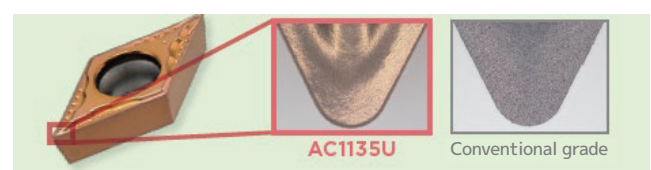


Fig. 5. Comparison of appearance after special surface treatment

and smooth surface. Combined with the aforementioned coating, this treatment significantly reduces chemical and physical built-up edge formation, suppresses tool wear and minor chipping, and achieves higher machining stability and better surface finish quality compared to conventional grades.

4. Cutting Performance of AC1135U

Figure 6 shows the results of a wear resistance test on stainless steel SUS316L. Thanks to the fusion of our proprietary coating technology and special surface treatment, AC1135U significantly suppressed tearing on the machined surface.

Figure 7 shows the results of a wear resistance test for continuous turning of alloy steel SCM415. By suppressing the progression of built-up edge wear, flank wear was reduced to half compared to competitor grades at the same machining length. As a result, a significant difference was observed in terms of dimensional stability.

AC1135U is also used for end-cutting inserts. As shown in Fig. 8, in the cutting-off of SUS316L, AC1135U reduces adhesion the cutting edge, achieving 1.7 times longer tool life compared to our conventional grades. In addition, tearing on the processed end face was greatly reduced, making this grade suitable for finishing processes where cutting-off is the final step, enabling excellent end-face quality.

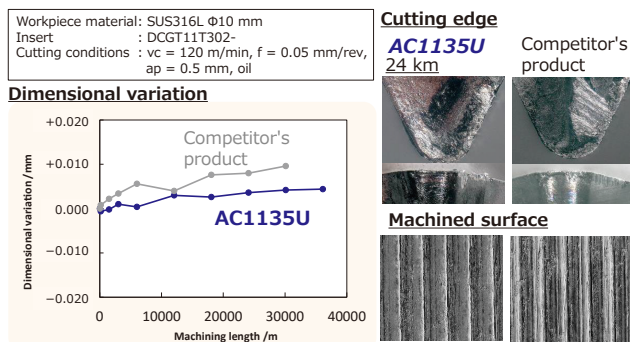


Fig. 6. Results of external turning on SUS316L

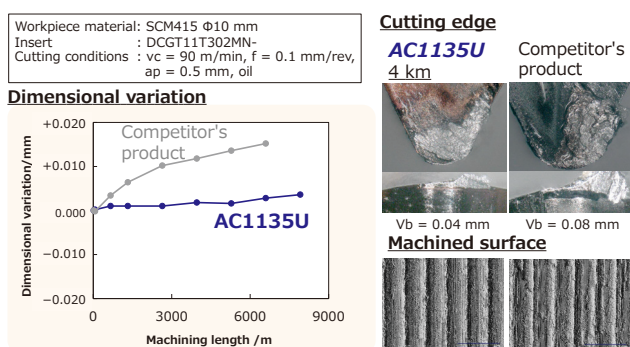
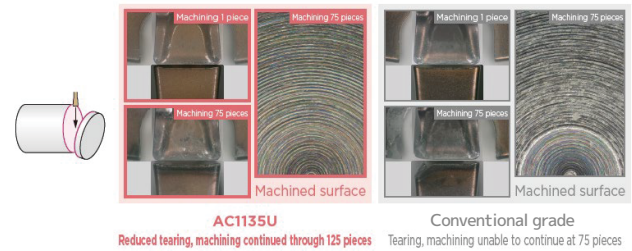


Fig. 7. Results of external turning on SCM415

Achieves 1.7x longer tool life than conventional grades and reduced tearing on machine surface



Work Material: SUS316L Cut-off $\phi 10$ mm Insert: GCMN2002-GF
Cutting Conditions: $n = 3,000$ min⁻¹ $f = 0.05$ mm/rev Wet (oil-based)

Fig. 8. Results of the cutting-off of SUS316L

5. Examples of AC1135U Usage

User machining cases using AC1135U are shown in Figs. 9 to 13.

Figure 9 shows a case of machining a medical component (workpiece: SUS316). AC1135U demonstrated 1.6 to 1.8 times longer tool life than conventional grades by suppressing adhesive chipping due to its excellent adhesion resistance.

Figure 10 shows a case of machining bicycle parts (workpiece: SCM415) with AC1135U. AC1135U suppressed the progression of crater wear and achieved 2.5 times longer tool life compared to conventional grades.

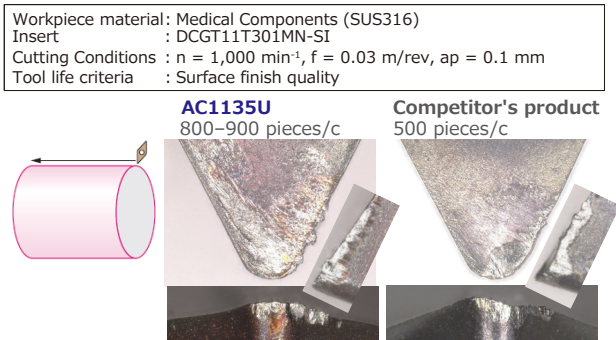


Fig. 9. AC1135U machining example 1

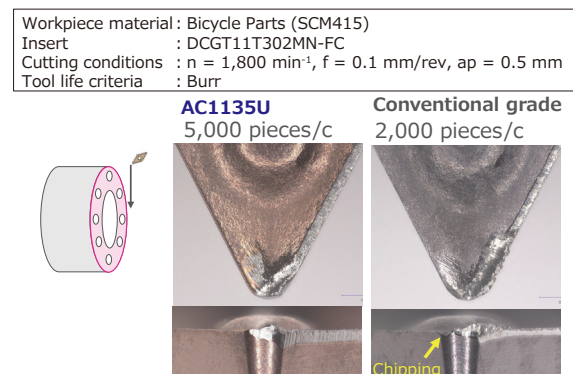


Fig. 10. AC1135U machining example 2

Figure 11 shows a case of machining automotive parts (workpiece: pure iron) with AC1135U. By combining a special surface treatment that smooths the rake face with a coating featuring excellent adhesion resistance and strength, AC1135U suppresses chipping caused by rake face damage and built-up edge formation. Even after machining the same number of parts, damage was minimal.

Figure 12 shows a case of groove machining automotive parts (workpiece: S45C) using AC1135U. AC1135U suppressed crater wear progression and achieved double the tool life compared to competitor grades. Furthermore, AC1135U demonstrated excellent chip segmentation.

Figure 13 shows an example of cutting-off semiconductor manufacturing equipment parts (workpiece:

SUS304) with AC1135U. The grade suppressed adhesive chipping at the shoulder and maintained good surface finish quality, resulting in 3.5 times longer tool life than our conventional grades.

6. Conclusion

AC1135U, with its proprietary coating technology and special surface treatment, demonstrates excellent adhesion resistance and wear resistance in machining with such as Swiss machine. We are confident that it can significantly contribute to reducing tool change frequency and machining costs.

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

Technical Term

- *1 Physical vapor deposition (PVD): A method in which the target material is ionized by arc discharge or similar means, reacts with a gas, and deposits as a ceramic film onto the substrate.

Reference

- (1) T. Yamanishi et al., “AC1030U Grade for High Precision Machining,” SEI TECHNICAL REVIEW No. 190, p. 152-156 (2017)

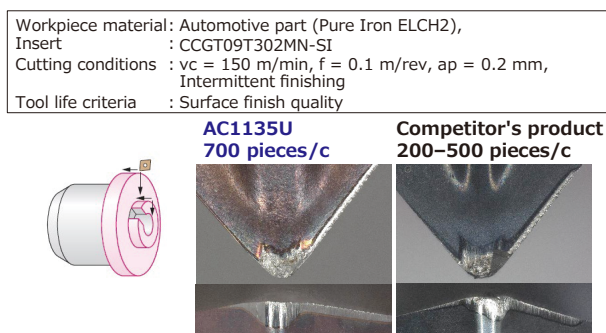


Fig. 11. AC1135U machining example 3

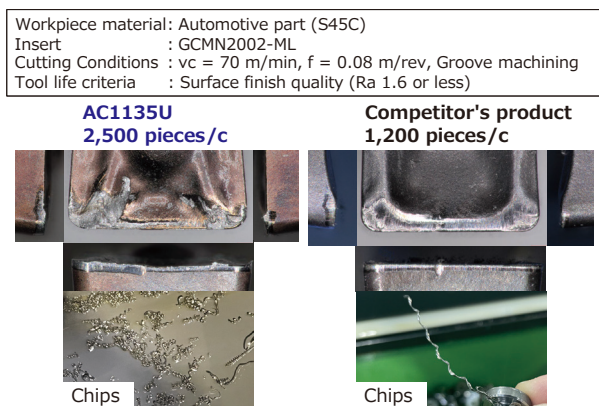


Fig. 12. AC1135U machining example 4

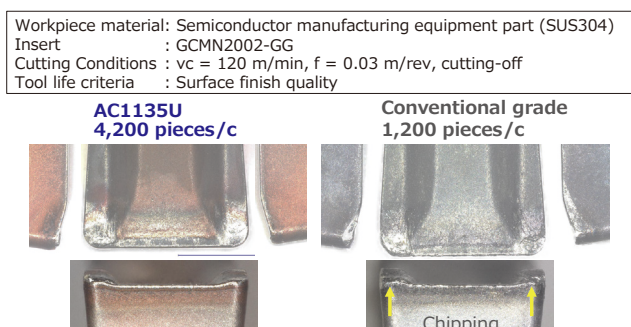


Fig. 13. AC1135U machining example 5

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

- Sumitomo Electric Hardmetal Corp.

**Y. SUZUKI**

- Assistant Manager, Sumitomo Electric Hardmetal Corp

**N. MATSUSHITA**

- Sumitomo Electric Hardmetal Corp.

**T. YAMANISHI**

- Assistant Manager, Sumitomo Electric Hardmetal Corp.

**S. OKUNO**

- Manager, Sumitomo Electric Hardmetal Corp.

