Development of Cermet Cutting Tool by Powder Injection Molding

Seong Taek Chung[1,a] and Young Sam Kwon[1,b]

[1]CetaTech, Inc., TIC 296-3, Sacheon, Kyongnam, 664-953, Korea
[a]stchung@cetatech.com, [b]yskwon@cetatech.com

Abstract

Chip breaker of cutting tool is an important feature to enhance cutting performance. Powder injection molding process was used to produce a triangular-shape cermet grooving insert which has three chip breakers. Attrition milled cermet powders were mixed with wax-based binder system in continuous twin screw extruder. Three-plate injection mold with slide cores was used to produce injection-molded parts. After molding, solvent and thermal debinding was carried out. Sintering was conducted in a batch furnace with a graphite heater. The sintered parts satisfy the requirements of dimensional tolerances and material properties.

Keywords : cutting tool, chip breaker, powder injection molding, three-plate mold, slide core

1. Introduction

Powder injection molding uses the shaping advantage of plastic injection molding but is applicable to metals and ceramics. This process combines a small quantity of a polymer with an inorganic powder to form a feedstock that can be molded. After shaping, the polymer binder is extracted and the powder is sintered [1].

Cemented carbides processed by powder injection molding are widely used as wear and cutting parts. A chip breaker of cutting tools is known as an important feature to enhance cutting performance. But it is impossible to form chip beaker perpendicular to die open direction by conventional powder compaction process. In this study, powder injection molding was used to produce a triangular-shape cermet grooving insert which has three chip breakers, as shown in Fig.1.

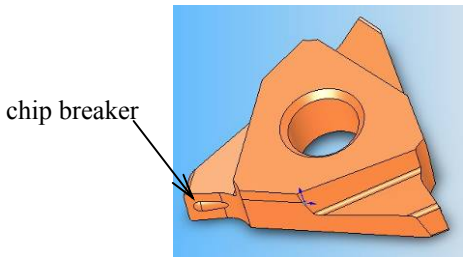


Fig. 1. Grooving insert with three chip breakers.

2. Experimental and Results

Attrition milled cermet powder and wax-polymer binder system was mixed to make powder injection molding feedstock. To determine the proper solids loading, torque rheometer experiment was conducted, as shown in Fig.2. Feedstock solid loading of 50% was selected for the success of subsequent processes.

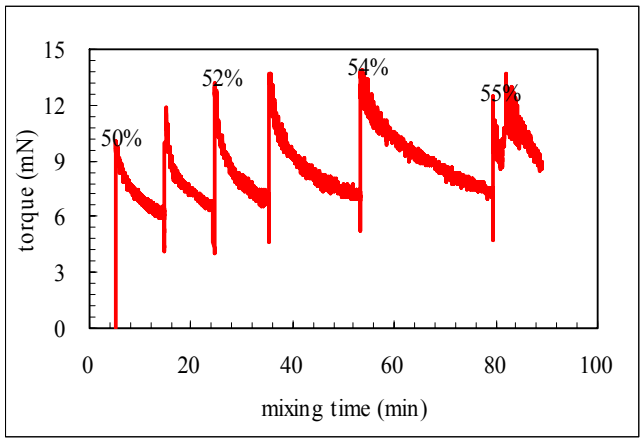


Fig. 2. Mixing torque as a function of the mixing time at various levels of solids loading.

To ensure uniform mixing, powder and binder system was mixed using continuous twin screw extruder. Fig.3 shows the pelletized feedstock of cermet powder.

Fig. 3. Pelletized feedstock of cermet powder.

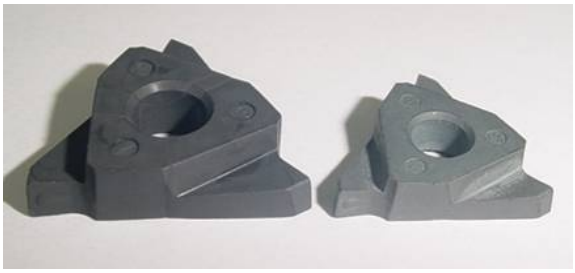
Three-plate injection mold with three slide cores was used to produce triangular-shape injection-molded parts with side chip breakers as shown in Fig. 1. Injection molding conditions was selected to avoid molding defects. Table 1 provides the important injection molding conditions.

Table 1. Injection molding conditions

injection temperature	155 °C
mold temperature	50 °C
fill time	0.24 s
packing time	1.0 s
packing pressure	80 bar

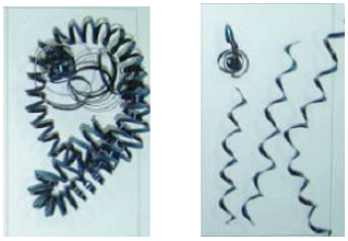
After molding, solvent and thermal debinding was carried out. Sintering was conducted in a batch furnace with a graphite heater. Fig. 4 shows the injection-molded part and sintered part. One can find the shrinkage in size associated with sintering a powder injection molding component.

The sintered parts satisfy the requirements of dimensional tolerances and material properties. Fig. 5 shows cutting chips with powder compaction insert and powder injection molding insert. Powder injection molding insert developed in this study was found to have chip breaking effect.



(a) (b)

Fig. 4. Injection-molded part (a) and sintering part (b).



(a) (b)

Fig. 5. Cutting chips with powder compaction insert (a) and powder injection molding insert (b).

3. Summary

In this study, a triangular-shape cermet grooving insert with three side chip breakers was successfully developed using powder injection molding process. The sintered parts satisfy the requirements of dimensional tolerances and the cutting performances.

4. References

1. R. M. German and A. Bose, Injection Molding of Metals and Ceramics, MPIF (1997).