

Two-layered Cutting Tool Tips with Thin Sintered Carbide Plate on Rake Face

Vasilenko Andrey Anatolyevich

1. Introduction

The principal driving force behind the development of new cutting tools has always been an increase in machining process productivity, whereas the aim of the development of new engineering materials has been the improvement of their mechanical properties, such as strength, toughness, hardness, etc. Consequently, new engineering materials lead to the problem of a significant decrease of cutting tool lives in machining such materials, and to the problem of dramatic decreases of material removal rates per cutting tool tip. This, clearly, is the reason for the ever increasing overall consumption of cutting tool materials. Many cutting tool materials have been developed so far, but sintered carbide cutting tungsten carbide (WC) system tools, including those used as a base for coated tools, comprise more than half of cutting tool material production. However, current global market trends have resulted in serious concerns that it may be difficult to ensure a stable supply of elemental tungsten and other rare metals in the future, which are currently used as the raw materials for sintered carbide cutting tools.

Based on the facts that the area of contact between a cutting tool and the material being worked is confined within a narrow region adjacent to the cutting edge, and that tool life in many cases is controlled by an increase of cutting forces and heat generation due to the progress of wear on the tool's flank face, two-layered cutting tool tips with a thin sintered carbide plate on rake face (TSCP) are proposed and investigated in this study.

2. Results and Discussions

The process of preparation of the two-layered cutting tool tips, tested in this study, mainly involving the hot isostatic pressing (HIP) sintering and the HIP diffusion bonding, is described in details. The reason for the HIP technique application and the basic technological

problems, encountered in the course of the sintering process improvement, are discussed.

Results of cutting tests for the two-layered cutting tool tips, assembled of the thin sintered carbide plates, made of the JIS K10 sintered carbide, and the pure copper, the JIS S45C carbon steel and the zirconia beads – JIS SUS304 stainless steel composite base materials, are discussed, and the effect of the base material kind on the two-layered tool tips cutting performance is studied. As mentioned in the Introduction, cutting force limitation mechanism at large wear land widths for the two-layered cutting tools is experimentally confirmed.

Results of cutting tests for the two-layered cutting tool tips, assembled of the thin sintered carbide plates, made of the JIS M20 and K10 sintered carbides, and the zirconia fine powder – JIS SUS304 stainless steel composite base material, are discussed and the effect of kind and thickness of the thin sintered carbide plates, as well as the effect of coolant on the two-layered cutting tool premature failure are studied. It was established that controlling the studied factors, and thus preventing the premature tool failure, it is possible to produce the two-layered cutting tool tips with cutting performance comparable to that of the conventional homogeneous tool tips.

3. Conclusions

Flank wear and cutting forces were measured and the following conclusions were reached. The tool life of two-layered tip with M20 TSCP was comparable to that of M20 homogeneous tip using mist cutting, while the tool lives of two-layered tip with M20 TSCP during dry cutting and two-layered tip with K10 TSCP using mist cutting were shorter than the tool lives of their homogeneous counterparts because they failed due to the TSCP fracture. The main factors of the fracture were: less TSCP flank width in the failed tips, higher cutting temperatures in dry cutting than in mist cutting, higher Young's modulus of K10 sintered carbide than that of M20 sintered carbide.