High speed machining of cast iron using CVD oxide coating and structure modified thick PVD AlTiN coating

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Thick Al2O3 coating deposited by thermal CVD process is still dominantly used for wet high speed turning of cast iron, mainly because of superior high temperature stability. There are some concerns about thermal CVD process, however, such as safety issue coming from somewhat hazardous gaseous sources. PVD process has advantages over CVD process in terms of easy operation and variety of coating material choice. Generally, hard coatings deposited by PVD process with highly ionized plasma are characterized by high degree of compressive stress and maximum coating thickness is usually limited less than 10 microns or even 5 microns on the sharp cutting edge. This has made PVD process not suitable for applications where thick coating is required. Kobe Steel has developed a new type of arc cathode which is able to control the residual stress in a wide range and this made it possible to produce thicker coating without chipping or delamination from the substrate.

Evaluation of cutting performance was done by turning test using WC-Co insert PVD coated approximately 10microns thick AlTiN and commercially available CVD coated TiCN/Al2O3 were used as references. Two types of PVD coated AlTiN coatings were used: monolayer and bias voltage modulated multilayer. Cutting speed is 300 m/min., feed is 0.25mm/rev., depth of cut is 2mm, and work-piece is ductile cast iron (AISI 80-55-06), under wet (emulsion) conditions. From the comparison of flank wear, PVD coatings showed improved tool life by optimizing coating conditions. Especially, bias multilayered AlTiN showed longer tool life than CVD coating: CVD coating almost reached the tool life (as defined by 300 microns of flank wear) after 2700 m of cutting length, whereas flank wear width was much smaller for AlTiN thick coating, which proves good wear resistance. In order to achieve the further improvement, effect of surface texture such as roughness on cutting performance was investigated. Additional cutting tests result will be presented using different coating systems as well as surface texture and discussion on the effect of coating properties such as hardness, residual stress of coating, and substrate material on wear mechanism.

Keywords
cutting tool
PVD