PO2036

Wear behavior of different PVD coatings in Ti alloy machining

KENJI YAMAMOTO[1], Hiroaki Nii[1], German Fox-Rabonovich[2], Danielle Covelli[2]

[1]Kobe Steel Ltd, Kobe, Japan [2]McMaster University, Hamilton, Canada

yamamoto.kenji1@kobelco.com

Weight ratio of Ti alloys used in modern aircraft is increasing due to good compatibility with CFRP composites. Ti alloys, as represented by conventional Ti-6Al-4V, are known to be hard-to-cut materials because of low thermal conductivity and high chemical reactivity against tool material. Although conventional TiAlN coating is still widely used for this application, apparently more advanced coating is necessary for achieve higher efficient machining.Different types of PVD coating were tested in Ti machining in roughing condition. Cutting conditions are as follows: workpiece Ti-6Al-4V, v=45m/min, f=0.15mm/rev, DOC=2.0mm and wet cutting. Standard TiAlN and Zr, Nb containing coatings (ZrN/NbN multilayer) were deposited by arc ion plating system onto WC-Co cutting insert (CNMG432). These coated inserts were subjected to above mentioned cutting test and after certain length of cutting, wear amount (flank side) was measured and worn section was further investigated by different analysis such as SEM-EDX and cross-sectional TEM. TEM observation of remaining coating on the flank face suggested different wear mechanism is working for TiAlN and ZrN/NbN. In case of TiAlN, Intensive sticking Ti work piece is observed on the surface of the worn part, sticking Ti is in direct contact with the TiAlN coating and no surface oxide was observed. On contrary to this, in case of ZrN/NbN coating surface of the worn part is covered with Zr, Nb containing oxide and quite few sticking of Ti was observed. Temperature of the flank face during the cutting was calculated by FEM based simulation and it was around 500 degree C. The estimated cutting temperature is far lower than starting temperature of the oxidation of TiAlN which is around 800 degree C, but close to the one with ZrN or NbN. Formation of the oxidized layer during the cutting prevents Ti sticking, but in case of ZrN/NbN, oxidation wear is taking place faster than expected. It was concluded that both lubricity which prevents Ti sticking and enough oxidation resistance is necessary for the coating of Ti machining.

Keywords
Ti machining
arc deposition
aircraft
cutting tool
wear