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Study of Different types of Coatings used for cutting tools for enhancement of performance

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Introduction : Metal cutting is the removal of metal from work piece in the form of chips in order to obtain a finished product with desired shape, size and surface finish. Virtually all producing units for example automobiles, railways, aircraft manufacture, shipbuilding, home appliance , consumer electronics and construction industries etc required large shops with many thousands of machining .The machining cost amounts to more than 15% of the value of the all manufactured products in all industrial countries. Of all the processes used to shape and size the metals in metal cutting process the conditions of operation can be varied to a high extent to improve the quality and the rate of producing parts with a reduced cost.

Key words : cutting, tools, coatings, hard coating etc.

Coatings for enhancement of performance :

Different types of coatings are used on cutting tools for enhancing their performance during machining operations. On the basis of composition, structure and nature these coatings can be classified are as follows:

(1) Conventional hard coatings
(2) Multicomponent alloy coatings
(3) Multilayer coatings
(4) Composite coatings
(5) Soft coatings
(6) Super lattice coatings
(7) Super hard coatings

S.NO.	Coatings	Examples
1	Conventional hard coatings	TiC, TiN, TiCN, Al2O3, HfC ,HfN

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2	Multicomponent alloy coatings	TiAIN, TiCrN, TiVN
3	Multilayer coatings	TiC/TiCN/TiN,TiC/TiN/Al2O3, TiC/TiCN/TiN/Al2O3
4	Composite coatings	Ti + MoS2, TiN + MoS2
5	Soft coatings	MoS2, WS2
6	Superlattice coatings	TiN/NbN, TiN/VN
7	Superhard coatings	Diamond and CBN

Table 1. Classification of various types of coating with their examples

Coating processes

Coatings can be deposited on the tool substrate by different vapour deposition techniques. These techniques helps to achieve the desired degree of accuracy in terms of uniformity of coating material over the substrate and coating thickness. The various types of processes that are used for depositing the tool coatings are as follows:

(1) Chemical vapour deposition process (CVD)

(2) Physical vapour deposition process (PVD)

Chemical Vapour Deposition (CVD)

CVD technique deposits thin films of coating material on the cutting tools through various chemical reactions. Coating of cemented carbides by CVD method, became more popular because it was introduce in the late 1960's. Due to the fact that chemical vapour deposition technologies became advanced from single layer to multi layer versions combining TiN, TiCN, TiC and Al2O3. Recent CVD coatings combine high temperature and medium temperature processes that produce excellent wear resistant coatings with a total thickness of 4-20 μm, with the high deposition temperature (950-1059°C) during CVD results in diffusion of chemical elements from the carbide substrate to the coating during growth. Embrittlement of the coating edge is the main effect of CVD process. In addition to the chemistry of the CVD process gives greater rapid growth at the cutting edge which results in an even coating thickness. So a strong driving force are there to find coatings that could be deposited at lower temperatures in order to

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allow tools with sharper edges to be coated and omit the embrittlement effect. The solution of this problem is PVD where deposition temperature can be kept at around 500°C.

Working Of CVD

Chemical vapour deposition is a chemical process which is used to produce highly pure and high performance solid materials. In a typical CVD process, substrate is exposed to one or more evaporative precursors, which react and decompose on the substrate surface to produce the desired and suitable coating. Often, volatile by-products are also formed, which are removed by gas flow through the reaction chamber. There are various applications of CVD process such as in microfabrication processes CVD is widely used to deposit materials in different forms i.e. monocrystalline, amorphous, epitaxial and polycrystalline. These materials consists silicon, filaments, carbon fiber, carbon nanofibers, carbon nanotubes, SiO2, tungsten, silicon-germanium, silicon carbide, silicon nitride, silicon oxynitride, titanium nitride, and different high dielectrics. The CVD process is also used to produce synthetic diamond.The results shows that the CVD coating is used to improve the production.

Physical Vapour Deposition (PVD)

PVD method deposits thin films on the cutting tools through physical techniques, mainly sputtering and evaporation. PVD coatings, with deposition temperatures of 400-600°C, are gaining greater acceptance in industrial market. From last so many years, PVD have been successfully applied to carbide metal cutting inserts. It gives advantage in various applications such as interrupted cuts, those requiring sharp edges, as well as finishing.

Fig.5 Different stages of PVD coating technique

Various kinds of PVD process that are used for depositing the thin films are as follows:

(1) Cathodic arc evaporation

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(2) Electron beam deposition

(3) Pulsed laser deposition

(4) Sputter deposition

The main reasons for depositing the PVD coatings are they pertains improved hardness and wear resistance, improved oxidation and reduced friction. But due to its high capital cost involvement and low deposition rates makes them unfit for use where there is restriction in terms of time and money.

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