UDC 620.22 (075)

MODERN POWDER (SINTERED) HARD ALLOYS

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Modern powder (sintered) hard alloys are compositions consisting of hard, refractory compounds (carbides and carbonitrides of titanium, tungsten, tantalum, etc.) in combination with a cementing (binding) component (cobalt, nickel, molybdenum, etc.). Hard alloys used to equip cutting tools can be divided into four groups by composition and application areas: tungsten–cobalt VK (WC–Co), titanium–tungsten TK (WC–Co TIC–Co), titanium tantalum tungsten TTK (WC–TiC-TaC-Co), tungsten-free BVTK (based on TiC, TiCN with various binders).

The application of powder metallurgy methods in the early 1920s in Germany led to the creation of new materials with a unique combination of properties - hard alloys. The attention of researchers was attracted by compounds of some metals with carbon: tungsten, titanium, tantalum, niobium carbides, which have high hardness and melting point.

Tungsten carbide WC has a hexagonal lattice and is much closer in properties to metals than to ceramics: it has good electrical and thermal conductivity, and has a metallic appearance. Other carbides have a cubic crystal lattice.

Tungsten carbide was mixed with a finely divided metal powder from the iron subgroup (iron, nickel or cobalt). The mixture of powders was pressed into a compact mass, which was sintered in hydrogen at a temperature of 1300 °C. As a result, a material was obtained consisting of highly dispersed WC grains bonded or "cemented" by a more viscous metal.

Hard alloys have high hardness at room temperature. With an increase in temperature, the hardness of hard alloys decreases, but still remains significantly higher than that of high-speed steel. Hard alloys are characterized by high values of elastic modulus (E = 500-700 GPa) and compressive strength (□*c* = 6 GPa). At the same time, they have a relatively low bending strength (□*b* = 1-2.5 GPa) and a lower impact strength than that of high-speed steels.

These physical and mechanical properties provide the carbide tool with a high limit of plastic strength, increased resistance to adhesive fatigue, chemical oxidation, diffusion and abrasive wear. Such properties made it possible to significantly increase the processing performance of steels, cast iron, non-ferrous alloys and hard-to-process materials compared to processing with a high-speed tool. Tungsten-cobalt alloys are most effective mainly in the processing of cast iron, non-ferrous metals, fiberglass, porcelain, hard-to-process materials (corrosion-resistant, high-strength steels, heat-resistant alloys based on nickel and titanium, etc.), i.e. materials that, as a rule, give discrete types of chips (elemental, fracture chips).

With the same cobalt content, the physico-mechanical and cutting properties are largely determined by the grain size of the carbide phase, mainly by the average grain size of tungsten carbide. The developed technological techniques make it possible to obtain hard alloys in which the average grain size of the carbide component can vary from fractions of a micron to 10-15 microns.

Later it was found that the most effective metal for the binding is cobalt. The obtained materials have a unique combination of properties, which led to their separation into the second main group of tool materials - the group of hard alloys.

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