

## COMPOSITION AND JUSTIFICATION OF HARD ALLOYS IN COMPOSITE MATERIALS

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**Abstract:** This article presents the essence, composition, types, and significance of composite materials in modern industry. Composite materials are formed by combining two or more different substances, distinguished by high strength, lightness, and resistance to heat and corrosion. Their wide application in technical and industrial fields contributes to improved efficiency.

**Keywords:** Composite materials, wear resistance, filler, technology, strength.

According to the predictions of well-known scientists about the wide prospects of composite materials in the fight against part wear, our research on the selection of materials for the restoration of worn parts has shown that it is possible to control the service life of a part and its joints within a wide range by determining the composition, shape, and structure of the welded layer obtained from powder composite materials. To achieve this, we needed to study various types, compositions, properties, and fields of application to identify the most suitable ones for further research.

The continuous increase in the production of machinery, along with the depletion of material resources on our planet, requires reducing the manufacturing of new parts through the reuse of existing ones. Therefore, it becomes essential to utilize new materials that can significantly enhance wear resistance when restoring worn parts.

The conducted research has made it possible to narrow down the range of materials suitable for obtaining highly wear-resistant layers.

The term “refractory metals” refers to metals whose melting temperature is higher than that of iron (1539°C). The following table presents certain elements used in mechanical engineering, their abundance in the Earth’s crust, properties, and approximate global market prices..

The annual global production of primary materials is as follows: steel — 700 million tons, structural cast iron — 460 million tons, plastic materials — 100 million tons, construction glass and ceramics — 180 million tons, aluminum — 12.2 million tons, copper — 15.7 million tons, lead — 3.77 million tons, chromium (with chromite) — 14 million tons, nickel — 520 thousand tons, tungsten — 20 thousand tons, titanium (mainly titanium dioxide) — 4.5 million tons. In recent years, the production of composite and powder materials has shown the fastest growth rate.

The distribution of metals in the Earth’s crust determines their usability potential. Metals and alloys that are abundant and sufficiently mined can be planned for long-term use

Table

### Quantities and Properties of Some Elements in the Earth’s Crust

Metal	Melting Point (°C)	Density g/cm <sup>3</sup>	Abundance in Earth's Crust(%)	Approximate Price (USD/kg)
Copper	1083	8,94	0,01	15,7
Titanium	1668	4,5	0,61	39,4
Iron	1539	7,87	5,1	0,76
Aluminum	660	2,7	8,0	3,3
Chromium	1875	7,19	0,033	14,9
Molybdenum	2610	10,2	0,0003	39
Tungsten	3422	19,3	0,0001	54,5
Vanadium	1919	6,1	0,015	50
Tantalum	2996	16,6	0,00024	595
Cobalt	1495	8,9	0,004	39
Nickel	1453	8,9	0,018	35,5
Magnesium	651	1,74	2,4	3,05
Manganese	1244	7,21	0,03	4,5

From the table, it is clear that aluminum is the most promising metal for technical applications, as it is light and widely available. However, its melting point and oxide, belonging to the group of mineral-ceramic hard alloys, do not meet the requirements for electrical conductivity.

Among the metals with higher melting points than iron, titanium is the most abundant in nature, followed by chromium. Therefore, titanium and chromium are the most suitable metals for forming hard alloys.

Titanium, known as the “metal of the space age,” is sufficiently available in the Earth’s crust. Its advantageous properties compared to other metals have led to its increasing industrial use. Modern airplanes and spacecraft cannot be imagined without titanium.

Chromium and its alloys are widely used in engineering, as indicated by the high annual production of chromite. Chromium forms three carbides with carbon and six with boron. It is widely used to improve various metallic properties.

Tungsten has long been one of the most widely used materials among hard and rare metals. Its unique properties continue to make it one of the most important materials today. However,

recent research in the field of hard alloys aims to conserve tungsten due to its scarcity, high cost, and expanding application areas. Recycling tungsten-containing waste from production is also an important measure in conserving this metal. The high market price and limited availability of tungsten make it less feasible for use in restoring worn parts.

The conducted analysis allows for the following conclusions. For restoring worn parts, heat-formed hard alloys are the most promising materials for coating due to their high wear resistance. Based on their properties, natural abundance, and cost, titanium and chromium carbides and borides are the most suitable strengthening phases for heat-formed hard alloys. The “Refractory and Heat-Resistant Materials” plant in Chirchiq, Tashkent region, has the capability to produce heat-formed composite materials from various hard alloys, which provides an excellent foundation for implementing the restoration of worn parts with high wear resistance across the country.

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