DESIGN PRINCIPLES AND FORMING OF CERAMIC BINDERS FOR DIAMOND WHEELS WITH GIVEN PROPERTIES

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The use of diamond grinding wheels with ceramic binders can increase significantly (3-20 times) the cutting speed of hard materials. The efficiency of diamond wheels determined of mark, and the concentration of diamond grains and the binder properties. There are some important requirements to binders: the wetting of diamond, strong hold grains, high thermal conductivity, chemical inertness and thermal stability, which depends on the difference between the linear temperature expansion coefficients (CTE) of the binder and the diamond. Binder should provide a self-sharpening tool during grinding: as diamond grains blunt, it should wear and tear, helping the blunt grain to loss.

Ceramic binder formed by the partial or complete components melting during heat treatment (sintering of the abrasive-containing layer of tool). Existing ceramic binder compositions provide sintering of grinding wheels at high temperatures (1100 °C). In the development of the diamond wheels must be considered their disadvantages, such as a diamond graphitization at temperatures above 700 °C. So one of the main requirements when selecting binders is its fluidity (the binder softening temperature $T_{b.s.} \leq 600$ °C). Generally, the lower is $T_{b.s.}$ the higher is CTE. The exceptions are low-melting glass ceramic binders containing phase with a low values of CTE (willemite, celsian, spodumene, etc.).

The design of the fusible glass components for ceramic binder based on data of the components crystal-chemical characteristics effect on the glasses properties, on empirical data of glass in $PbO–B_2O_3–SiO_2$, $Na_2O–B_2O_3–SiO_2$ and $Na_2O–PbO–SiO_2$ systems, and the influence of additives phase-forming oxides (Li_2O, TiO_2, ZnO). Model glass compositions are close to the ternary eutectic of these systems. The content of components that are resistant to lubricating-cooling fluid is 80÷85 %.

The technological properties of glasses (viscosity and surface tension at the sintering temperature of diamond-bearing layer), their characteristics, determining the diamond wheels properties (elasticity modulus, compressive strength, CTE), as well as the crystallization ability and structural condition, that affects the extent of their crystallinity, were defined with calculation methods.

The study of the formation processes of low-melting ceramic binders has allowed to establish the phase composition and the temperatures of their crystallization and softening of designed glass components, which determining the temperature conditions of diamond-bearing layer sintering. Tests of the diamond wheels, made using the developed ceramic binders, confirmed the increase of terms of their effective operation and the reduction of diamond consumption in compared with circles with industrial binder (K1-01).