Investigation of the Degradation Processes Effect on the Properties of the Industrial Cutting Tool used in Packaging Process

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The paper investigates the metal structure carbide inhomogeneity of the cutting tool made from high-alloy steel, used in industrial process of packaging candies, after its service life period. The chemical composition of steel is current: C - 2.2%, Si - 0.4%, Mn - 0.35%, Cr - 12.12%, Fe - 84.8%, Mo - 0.12%. The increased content of carbon and chromium leads to the formation of an amount of special doped carbides in the composition structure. Accordingly to the X-ray diffraction analysis, it was detected that the type of carbides conforms to Cr_7C_3. The amount of carbides and their size were determined with the computer program ThixometPro. As indicated by the metallographic analysis of the separate zones of the tool, the size and the number of special doped carbides differ in the images of the metal structure. Therefore, the structure of the middle part and at the edge of the operating surface were comparatively analyzed. The total amount of carbides in the middle part of the tool structure equals 14.4% of the metal matrix and reaches 8.15% at the edge of the operating surface. The structural inhomogeneity and the presence of large doped carbides were detected in the middle zone, wherein, the share of small carbides is 20.8% of the total volume of the carbide phase. There is a lack of large special carbides and the area of 69.2% carbides is not exceeding 4.75 μm at the distance up to 100 μm from the edge of the working surface. Moving further from the edge, the area and volume of carbides increase. The carbide inhomogeneity along the cross-section occurs as a result of doped carbides crushing under the stresses action during the service life. From the working surface edge to the depth dispersed carbides are lining up at an angle of 45º, forming centers of crack initiation. In virtue of the analysis, it is recommended to apply an additional hardening by the PVD method to stabilize the operating surface layer under the deformation.

Keywords: carbide inhomogeneity; special carbides; doped carbides

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