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Predicting the intensity of physicochemical interaction between the abrasive and workpiece material depending on the chemical composition of the material machined

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Abstract

Physicochemical mechanism is one of the wear mechanisms of the abrasive grain in grinding. Existing scientific researches which deal with the wear of the abrasive grain show the presence of this wear mechanism but do not characterize it from the quantitative point of view. The article contains the results of the empirical studies on the physicochemical interaction between the abrasive grain and the workpiece material while grinding. The empirical studies allowed to determine the quantitative characteristics of physicochemical processes in grinding. The developed empirical models can predict the coefficient of chemical affinity for the workpiece materials with a variety of chemical compositions. The mathematical method used in this research makes it possible to define the size of the abrasive grain portion is worn as a result of such physicochemical interaction. In future, this circumstance will predict the extent of the abrasive tool wear under different technological conditions in order to define its operating capacity and apply the tool efficiently in multipart manufacturing.

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Keywords: physicochemical wear, abrasive grain, grinding.

1. Introduction

Grinding is the process of mutual fracture of two contacting solids: work and abrasive grains of the grinding wheel. It is supposed that the work material breaks more, and the cutting abrasive grains of the tool are worn during a long period of time – efficient tool life.

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One of the main ways of the abrasive grain wear in grinding is physicochemical one [1-10], while there are no quantitative characteristics of this wear in scientific and technical literature. To define the quantitative parameter (coefficient of the chemical affinity of the abrasive and workpiece material) we used experimental researches with the electron scanning microscope JSM 6460LV (JEOL, USA) [11]. As a result, we got the bulk of experimental data which allow us to estimate quantitative and qualitative influence of chemical composition of the material being grinded on the density of physicochemical interaction with the abrasive material (fig. 1).

Nomenclature

T	the temperature of the abrasive grain (temperature in the interface)
D_{af}	the coefficient of the chemical affinity of the abrasive and work piece materials

2. Research results

Analyzing the influence of the temperature in the contact zone of the abrasive grain and workpiece it can be concluded that the rise of temperature in the contact zone of the abrasive grain and work leads to the rise of intensity of physicochemical interaction between materials. Therefore, in the cumulative volume of the worn spot abrasive the part of the wear increases as a result of this wear mechanism.

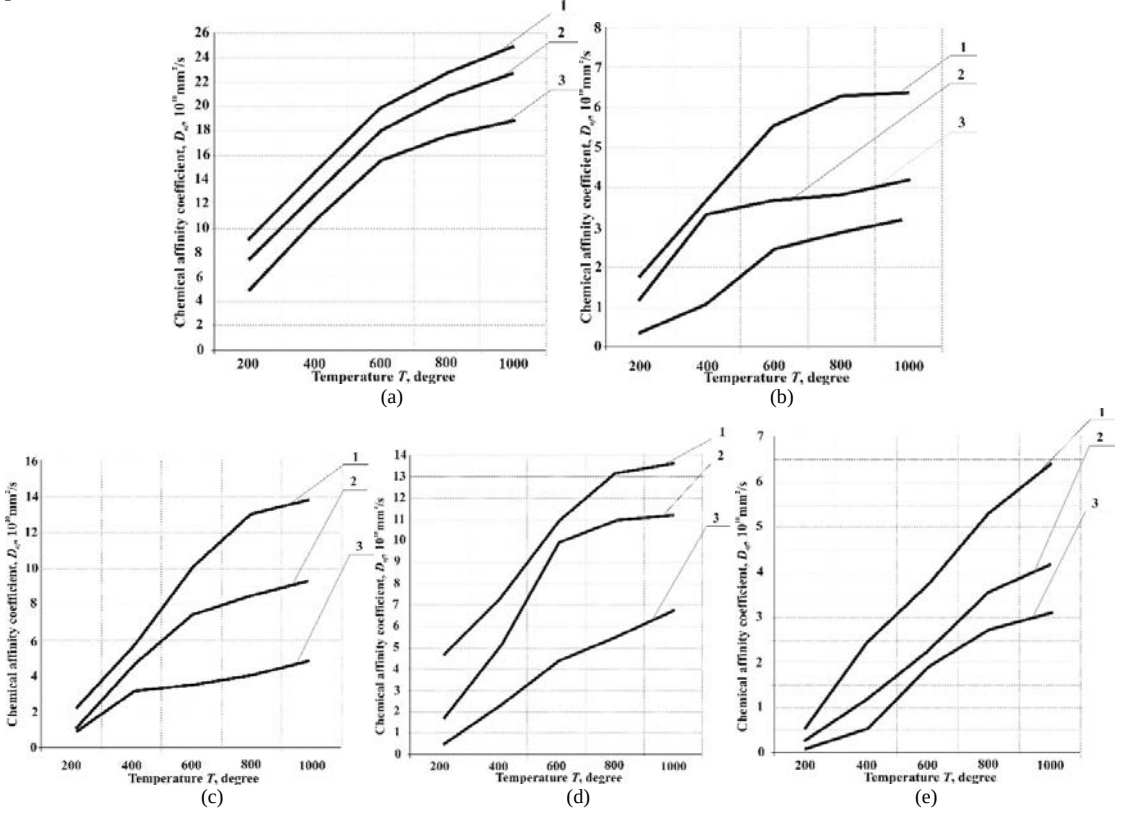

Fig.1. Dependence of the chemical affinity coefficient of different steels on temperature:
(a) 1 – steel 20, 2 – 30, 3 – 40; (b) 1 – steel 20X, 2 – 30X, 3 – 40X;
(c) 1 – steel 20X13, 2 – 30X13, 3 – 40X13; (d) 1 – steel 20XH, 2 – 30XH, 3 – 40XH;
(e) 1 – steel 20XH3A, 2 – 30XH3A, 3 – 40XH3A.