Chapter 33

THE EFFECT OF THE STRUCTURE OF A TWO-LAYER CUTTING INSERT ON ITS PHYSICOMECHANICAL CHARACTERISTICS

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Abstract The effect of the structure of a two-layer cutting insert on the specific electrical resistance and microhardness in its local regions has been studied. The existence of Co-enriched intermediate zone and the absence of cobalt in the composite at a distance above 60 μm from the composite-substructure interface change the electrical resistance of the cutting layer, decreases the microhardness of the zone to 23 GPa and facilitates high performance of the two-layer cutting insert.

Keywords: Structure, nanocomposite, cubic boron nitride, microhardness

1. INTRODUCTION

The development of composite materials with specified physico-mechanical characteristics (highest electrical conductivity, hardness, fracture toughness, wear resistance, etc.) is the principal task when devising technologies of sintering of superhard phases. In this case, of great importance is the monitoring of the composite structure: analyses of the chemical, phase and granulometric compositions, the relation of the formation of the homogeneity of the material structure and its physico-mechanical characteristics to the sintering conditions and the way of stirring of the components of the initial mixture.

Scanning electron microscope (SEM) is the universal instrument used to study surfaces and analyze the structure of solids. The problems of obtaining SEM images and using analog SEMs in studies of nanosystems in materials science are reviewed in [1]. A scanning electron microscope/PCI-bus of a computer interface is described in [2], which allows high-resolution 24-bit
images measuring 4096x4096 pixels to be obtained. It has been used to study the structure of the two-layer cutting insert. The requirements imposed on the software, which is to control a scanning electron microscope and accumulate the analytical information, are discussed in [3].

The aim of our present work has been to relate the electrical resistance and microhardness in local regions of the two-layer cutting insert to its structure.

2. EXPERIMENTAL DETAILS

2.1 Special Features of Hardware and Software for the SEM/PC Interface

There are two ways of solving the problem of the SEM/PC interface:
– capture of an image from the microscope electron-beam tube, preprocessing the image (a change in brightness/contrast, partial decrease of the detector noise), retention of the information on magnetic carriers;
– switching off X- and Y-generators of the SEM, transfer of control to PC, processing of the image in producing and retention on magnetic carriers.
In using the second way, the operator has a higher freedom of action and greater possibilities are opened up for processing of the analytical information that comes from various type detectors, by which the SEM is equipped.

The basic functions of the software are [3]
– controlling the SEM probe and entering the discrete analytical data from various detectors into the computer (scanning over the surface being analyzed in one of the specified directions; change of the time of accumulation of signals from the point being analyzed, etc.);
– analysis of the produced image (cancel of the old data and production of the new ones, variation of individual elements of the image matrix, the use of filters that improve the image, measurements of pores, particles, phases);
– save of the image on magnetic carriers in the BMP/JPG formats and analytical data in the xls/txt formats.

2.2 Studies of the structure of a two-layer cutting insert

Earlier we have studied [2] a miniature cutter made of the two-layer cutting insert of composition (WC-Co)–(cBN, TiN, AlN) using a microscope having an interface, which allows digital images measuring 4096x4096 pixels to be obtained. The structure of the material has been studied using secondary electrons; the distribution of chemical elements with the insert