Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 152 (2016) 608 – 612

Procedia Engineering

www.elsevier.com/locate/procedia

International Conference on Oil and Gas Engineering, OGE-2016

Antifriction superhard coatings for drill bits and boring cutters

Eremin E.N.[a]*, Yurov V.M.[b], Guchenko S.A.[b], Laurynas V.Ch.[b], Kasymov S.S.[b]

[a]*Omsk State Technical University, 11, Mira Pr., Omsk 644050, Russian Federation*
[b]*E.A. Buketov Karaganda State University, 28, University Street, Karaganda 100028, Kazakhstan*

Abstract

Coatings obtained by sputtering a stainless steel cathode and a plate titanium cathode cut from drill bit cutters JCS-M60 MX 172 544.00 are investigated. The measured microhardness of the plate drill bit is 1400 HV (Vickers) and that of coating 12Cr18Ni10T+Ti is 2200 HV that is significantly higher. The measured coefficient of dry friction for a drill bit plate on steel equals to 0.82, and it is 0.12 for coating 12Cr18Ni10Ti+Ti. Coating 12Cr18Ni10Ti+Ti deposited on the drill bit cutters in nitrogen gas may be used to modify the surface of drill bits and boring cutters to increase their lifetime. Such coatings, having a small friction coefficient, high hardness and low cost of production, can compete with traditionally used diamond materials.

Peer-review under responsibility of the Omsk State Technical University

Keywords: drill bit; multi-element coating; X-ray analysis; microstructure; nanostructure; microhardness; nanohardness; friction

1. Introduction

At present technologies that can increase durability (life) of parts and machine units are particularly important due to limited material resources in the industrial complex. In general 90% of parts and machines go out of operation due to surface wear. This is particularly essential both for oil and gas exploration and field development.

Grain synthetic diamonds with different properties and superhard materials are used to increase the drilling rate, but the cost of their production is rather high. In recent years, the technology of applying superhard coating on various parts, including drilling tools has been developed [1]. Such coatings for drill bits and boring cutters must satisfy two principal but opposite requirements. They should have a high hardness and a low dry friction coefficient. Nanostructural coatings [2] obtain these properties.

* Corresponding author. Tel.: +0-000-000-0000; fax: +0-000-000-0000 .
E-mail address: weld_techn@mail.ru

Peer-review under responsibility of the Omsk State Technical University
doi:10.1016/j.proeng.2016.07.663

2. Experimental

In this paper coatings produced by sputtering of steel cathode 12Cr18Ni10Ti and plate titanium cathode cut from KNSh-M60 MX 172 544.00 cutters drill bits are investigated. The coatings were applied on unit NNV - 6.6.I1 in argon and nitrogen gas environment over a period of 40 minutes at an arc current of I_i = 80 A, the reference voltage U_{ref} = 200 V and a gas pressure in the chamber $p = 5 \times 10^{-3}$ Pa.

The microstructure of the coatings is investigated on metallographic microscope Epikvant and electron microscope JEOL JSM-5910. To measure the microhardness Micro Durometer HVS-1000A is used. To determine the coefficient of friction the system for determining the wear and sliding friction [3], being constructed in the laboratory of the University of Karaganda, is used.

The thickness of the coatings and their elemental composition is measured using an electron microscope 200 Quanta 3D. The phase composition and structural parameters of the samples were performed on diffractometer XRD-6000 in CuK_α-rays. An analysis of the phase composition, the size of coherent scattering regions, the internal elastic stress (Δd/d) was carried out with the use of databases and PCPDFWIN PDF4+, as well as the program of full-profile analysis POWDER CELL 2.4. The nanohardness of coatings for the samples was determined by Oliver-Pharr nanoindentation system method and using Berkovich indenter with a load of 1 g and a dwell time of 15 sec.

3. Results of experiment

Fig. 1 shows the microstructure of 12X18H10T + Ti and Table 1 represents the phase composition. A dislocation structure can be noticed.

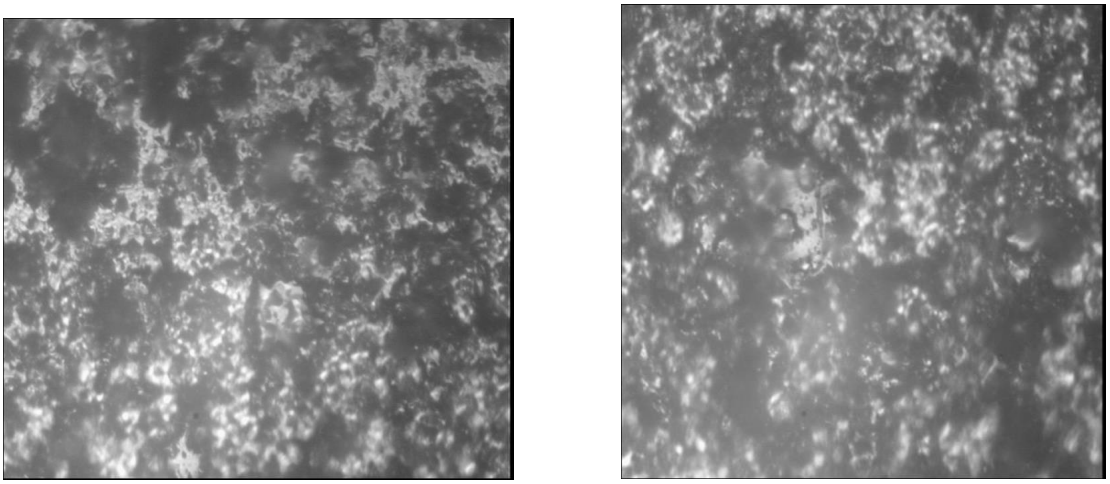

Fig. 1. Microstructure of coating 12Cr18Ni10Ti+Ti in nitrogen gas at two different points of sample (magnification ×400).

Table 1. Structural and phase composition of coating 12Cr18Ni10Ti+Ti.

Coating	Phase detection	Phase content, vol.%	Lattice parameters, Å	Size of CSR, nm
12Cr18Ni10Ti+Ti in nitrogen gas	$FeN_{0.0324}$	9.8	a=3.592	10.35
	TiN	85.5	a=4.240	14.71
	Fe-α	4.6	a=2.864	7.29