ELECTROPLATED NANOSTRUCTURAL COATINGS FOR DURABLE APPLICATIONS

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INTRODUCTION

Nowadays various micro- and nanosystems became a part of our daily live. However, manufacturing of such complex systems requires novel technologies and materials, which can fulfill diverse requirements [1]. Application of nanostructured materials as interconnect material in integrated systems can improve unsoundness, electrical characteristics and thus device performance. Usage of roll-to-roll technology for hologram manufacturing is due to its high throughput, 3D repeatability of mold and low cost of production [2]. Micro- and nanoelectromechanical systems (MEMS and NEMS) are the most promising state-of-the-art devices. Mechanical interaction between nano-, micro-, and macro world is the limiting factor for such a complex system. The use of nanocomposite materials is the most promising method to solve the reliability issue [3, 4].

NANOCOMPOSITE MATERIALS FOR ROLL-TO-ROLL TECHNOLOGY

Patterned holographic foils as printing matrixes in roll-to-roll technology with high runability were made (Fig. 1).

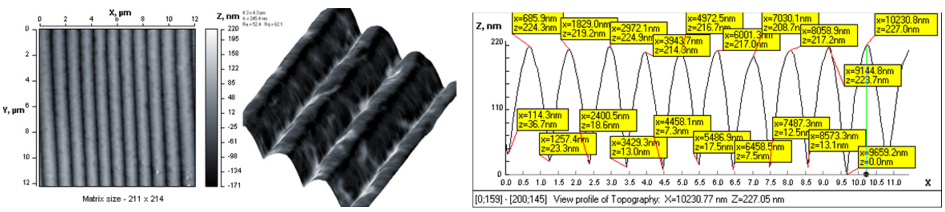

Fig.1. Topography and 3D image of nickel samples of copies

Composite metal films based on nickel and chromium have been electroplated for this purpose. The influence of the electrolyte composition, the particles concentration and other parameters on the coating properties was identified. The thickness of the electroplated composite films varied from 5 to 100 nanometers. The coatings demonstrated outstanding mechanical properties: microhardness is equal to 584-794 kg/mm^2, runability improved in 2-3 times compare with conventional matrixes.

NANOFABRICATION FOR COMPLEX SYSTEM'S INTERCONNECTIONS

Defect-free coating of the complex pattern is a serious problem in interconnect layers of integrated systems, such as the solid oxide fuel cells (SOFC), ultralarge scale integration

(ULSI) and nanostructures with irregular shape [5]. Metallic materials based on cobalt (Fig. 2) and copper (Fig. 3) have been electroplated in trenches of 170-300 nm wide.

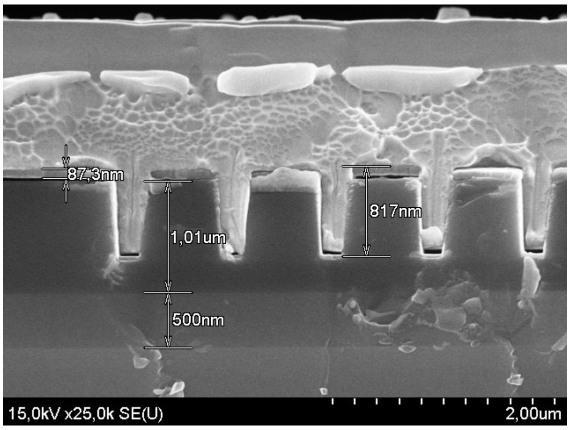

Fig. 2. Cobalt based coating with 170 nm wide patterns

Typical defects like voids, seams and reasonably coarse surface were not observed in the deposited coatings. The copper film has low electrical resistance and high electromigration resistance. These properties are highly important for interconnects. Plated cobalt-based coating has excellent magnetic properties, that can be used in magnetic recording systems, tracking systems based on Hall elements etc.

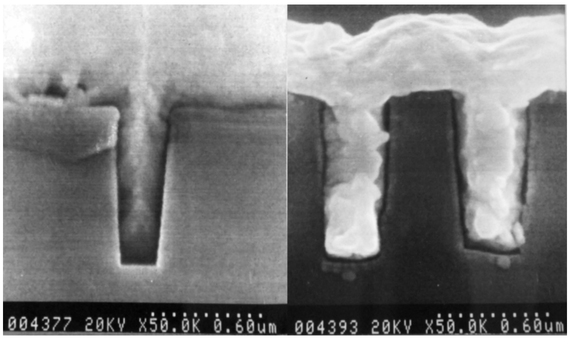

Fig. 3. Trench of 180 nm (left) and 285 nm (right) wide filled with copper

NANOCOMPOSITES FOR RELIABLE MICROMECHANICAL COMPONENTS

Composite coatings for MEMS applications based on nickel and cobalt were electroplated with inert nanoparticles of ultradispersed diamond (UDD), alumina, aluminium monohydrate, boron nitride. The size of the dispersed phase varied from 7 to 50 nanometers. The nanoparticles were incorporated into the metal matrix (Fig. 4).

In comparison with homogeneous coatings, nanocomposite coatings showed improved

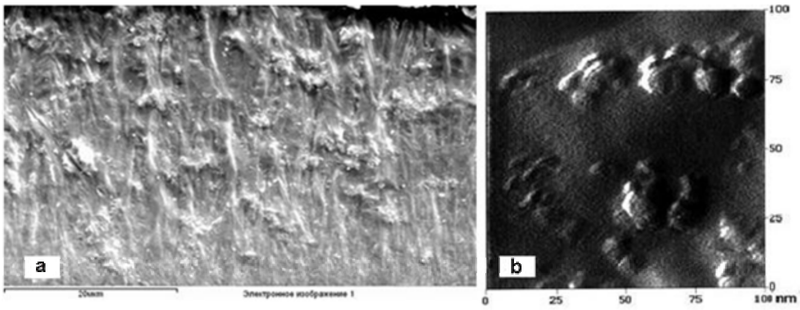

Fig. 4. Cross-section (*a)* and surface (*b)* of nicel nanocomposite coating

mechanical properties: the microhardness increased on 20-80%, the wear resistance increased in 4 times, the friction coefficient decreased in 2 times. Due to these mechanical properties nanocomposite materials will improve the reliability of moving parts of NEMS and MEMS (Fig. 5) and whole system at all.

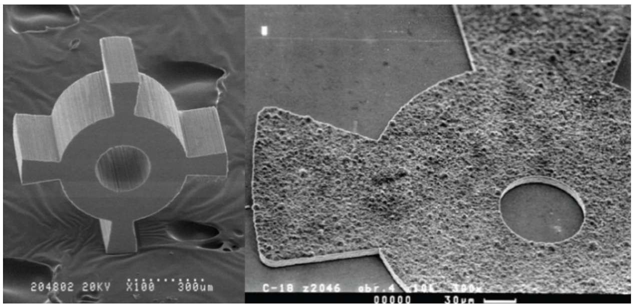

Fig. 5. Moveable microstructure based on nikel

CONCLUSIONS

This paper describes positive prospects of the nanocomposite and nanostructured electroplating introduced in modern technologies. Application in NEMS, MEMS, SOFC, ULSI, roll-to-roll, nanoimprint and other advanced systems and technologies makes it possible to improve quality and reliability of end products and enables their industrial development.

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