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Morphology of multilayer AlN/SiN coatings

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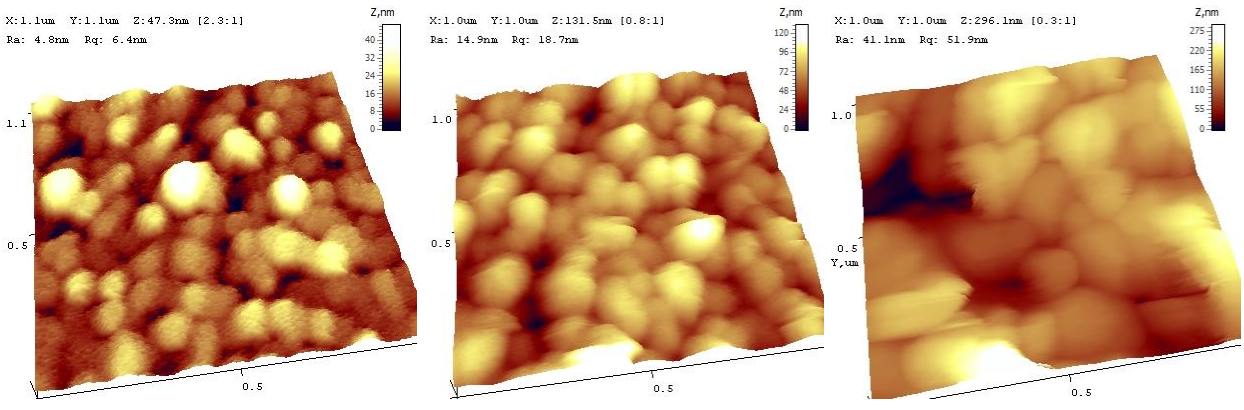
Coatings based on aluminum nitrides are optimal for operation in conditions of high temperature and mechanical stress. To increase their mechanical properties, slowing the cracks propogation, coatings are formed as multilayer structures with a period of layers from several to a dozen nanometers. Such a composition can be a sequence of layers AlN/SiN. The nanostructured state of the films, on the one hand, leads to a significant increase in their mechanical and functional properties; on the other hand, excess surface energy at the interphase boundaries leads the nanostructure to a nonequilibrium state, which in turn can lead to mechanical degradation of the films, especially at elevated temperatures under conditions open air atmosphere. AlN and AlN/SiN coatings were formed on monocrystalline silicon substrates with the (100) orientation by reactive magnetron sputtering with consecutive use of aluminum and silicon targets in Ar + N_2 plasma. The coatings thickness was about 300 nm. Multilayer coatings AlN/SiN were obtained with two thicknesses of single layer of 5 and 10 nm. The purpose of this work was to determine the effect of single layer thickness on the morphology of AlN and AlN/SiN coatings surfaces. AFM NT-206 (Belarus) was used in this work for the coatings surfaces characterization.

It was established that AlN coating surface consists of rounded crystals with diameter 50-100 nm (Fig. 1a). In this case, it has the lowest roughness of 4.8 nm at 1x1 μm^2 of scanned area. Despite the fact that this coating has the thickest layer of the same composition of 300 nm, the size of the crystals there is minimal. The surface of the AlN/SiN coating with layers of 5 nm consists of triangular crystallites with diameter of 100-150 nm. Its roughness at 1x1 μm^2 of scanned area is 14.9 nm (Fig. 1b). The surface of the AlN/SiN coating with layers of 10 nm consists of triangular crystallites with diameter of 150-250 nm. Its roughness at 1x1 μm^2 of scanned area is 41.1 nm (Fig. 1c). Thus, in spite of the small individual layers excluding the columnar growth of crystallites, the largest layer of AlN/SiN with 10 nm layers has the largest crystallite size, which on the one hand can reduce its mechanical properties, but on the other, increase the thermal stability due to the reduced area of intergranular boundaries compared with coatings with nanoscale crystallite size.



(a) (b) (c)

Figure 1. Three-dimentional images, scanned area 1x1 μm^2: (a) AlN, (b) AlN/SiN (5 nm), (c) AlN/SiN (10 nm).

1. V.M. Anishchik, V.V. Uglov, A.K. Kuleshov, et al., *Thin Solid Films* **482**, 248 (2005).