Structure and Morphology of Metal Films on Silicon Monocrystalline Surface

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Thin metal films were thermally deposited on the surface of monocrystalline silicon. It's structural features were investigated by ACM technique with Solver P47PRO. Structural features such as surface morphology, surface profile, geometrical sizes of nanocrystals and other parameters were conducted for metal films with thicknesses *d*: 2,5 nm, 10 nm, 50 nm, 100 nm, deposition rate 0,8 nm/c. Surface profile of all metal films is characterized by random topography and granularity hierarchy. Most probable growing mechanism for all metal films is Folmer-Weber mechanism. In particular, at start condensation during nucleation of metal film new phase is formatting as columnar pyramids with diameters 20-40 nm and height 10-15 nm. After Cu and Al metal films formation process is finished the distinctions between it's surface morphology become unnoticeable. The surface profile heights of all metal films demonstrate stochastic irregularity without any laws during thickness growth. Thin chromium films have significantly different surface morphology. At a minimum thickness randomly placed nanoobjects with pyramidal geometry the average distance between them 2-3 nm is observed. But most exotic phenomena is existents of clear and almost cylindrical nanovoids for thickness d_2 with average depth 1 to 4 micrometers. They reach the surface of substrate it's diameter around 2 nm and they are located at a distance 2 nm. With increasing of film thickness such peculiarities disappears after that the series of pyramid like columnar nanostructures with specific sizes is occurred. With surface morphology and profile investigation of thin metal films the statistical analysis of cluster images wich obtained by the standard method of cut on certain height. For numerical description of the clusters the Hoshena-Kopelmana algorithm were used. The statistical investigation of average distances between clusters showed that for Cu films that average distances is around 40-60 nm. With father increasing of film thickness the average distances do not change dramatically 51-56 nm. In the case of Al metal films we observe greater statistical dispersion and greater value of distances up to 170 nm but average distances approximately 52-90 nm. The Cr films demonstrate greater statistical dispersion in comparison with Cu and Al film but distances can reach up to 1300 nm. The average distances between closest clusters significantly increases up to 495-747 nm. Abnormally low value of surface inhomogeneitys observer for Cr films - 5,5 nm in comparison with Cu films that value is 0,3–0,4 micrometer. The surface morphology parameters of investigated metal films on silicon substrate first of all depend on thermalization of film created particles. It's depend on distinctions of the energy dissipation kinetics of molecular beam of specific metal for it's transition from strongly nonequilibrium state on substrate in metastable film state and peculiarities of interfacial interaction in the system of condensate-substrate. Those phenomena are characterized by energy and adhesive parameter such as: interfacial energy – γ_m, interfacial tension – σ_m, adhesion work – A_{ad} and adhesion energy – γ_{ad} in "metal-silicon" system.