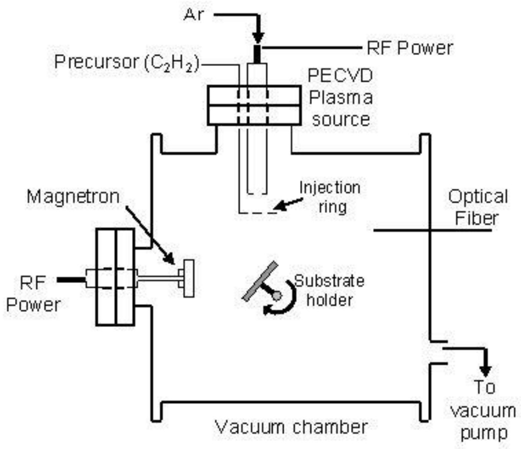
Hiden Reference: AP0088
Hiden Product: MAXIM SIMS/SNMS Workstation

Metal-carbon composites and multilayer thin films prepared by plasma assisted sequential deposition

Thin films incorporating mixed metal and carbon elements (like carbon-metal nanocomposites or multilayer thin films) find applications as functional coatings in many fields of modern technology. A novel plasma assisted deposition method (namely sequential deposition), combining magnetron sputtering (MS) and plasma enhanced chemical vapor deposition (PECVD) was implemented. Using the same deposition setup, the sequential deposition method proved to be able in producing either a-C:H/W nanocomposite or carbon tungsten multilayers.

Most of the plasma deposition methods used currently for production of metal carbon nanocomposite or multilayers involve simultaneously addition of the film constituents on the substrate. Using our approach it is possible to obtain composite films from separately deposited elemental constituents. The method consists in cyclic (sequential) exposure, for predefined time intervals, of a substrate to totally independent two plasma deposition sources, working in alternative sequences: MS in Ar for metal deposition and PECVD, in Ar and C_2H_2, for deposition of hydrogenated amorphous carbon (a-C:H). One deposition cycle consists in the following steps: metal deposition by MS, transport of the substrate in the front of PECVD, deposition of a-C:H, and backward transport of the substrate in the front of MS. The substrate is transported between the plasma sources using a stepper motor; during the substrate movement the plasma sources are not energized and proper gas composition for the following deposition step is prepared. Besides the plasma processes parameters (discharges power and gas composition) important process parameters are the temporal ones (duration of MS and PECVD processing steps, transport time, and the number of cycles).

The durations of plasma processes determine the composition and the degree of intermixing of the constituents in the deposited film, while its thickness is controlled by the number of successive deposition cycles. Such as, quasi-homogeneous nanocomposite films with elemental concentration ranging from 10 at % W and 80 at % C up to 40 at % of both W and C were obtained using plasma short exposures of a few seconds. Increasing the duration of plasma processes up to tens of seconds there were deposited multilayer films, consisting of successive C and W layers. The in-depth compositional profiles of both composite and multilayer structures were investigated using a MAXIM SIMS/SNMS Workstation from Hiden Analytical.



Schematic of plasma assisted sequential deposition setup.

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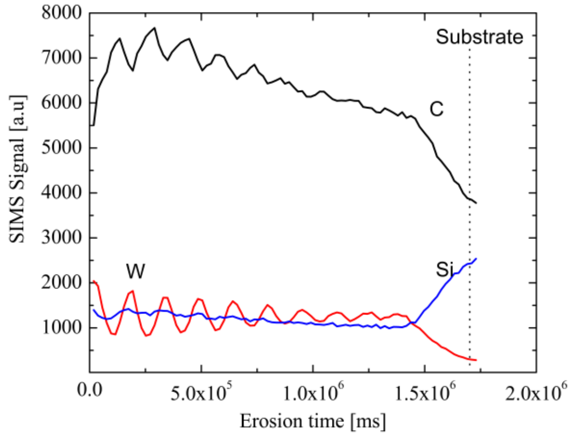
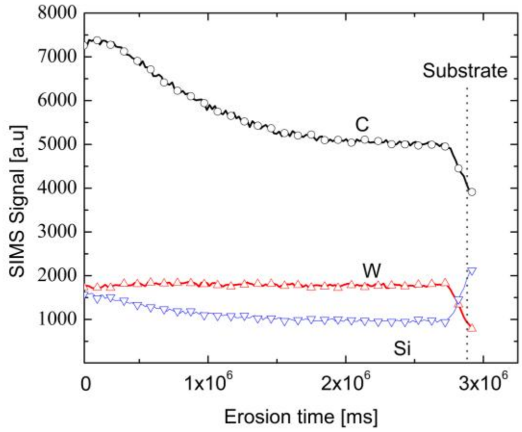


SIMS profile of a carbon tungsten multilayer structure



SIMS profile of a carbon tungsten nanocomposite structure

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