Hiden Reference: AP0371
Hiden Product: EQP Mass and Energy Analyser

In-situ monitoring of the growth of silver thin film – the influence of sputtering gas

We have been carrying out a systematic study of nucleation and growth of silver thin film prepared by magnetron sputtering in the Department of Analysis of Functional Materials of the Institute of Physics ASCR for several years. We have applied combination of several in-situ techniques, ie. spectral ellipsometry and electrical conductivity measurements to analyse properties of the growing film, optical emission spectroscopy (OES) and mass spectrometry (Hiden EQP 500) to investigate magnetron plasma properties. The experimental setup is shown in Fig. 1 and Fig. 2. The aim is to be able to control silver growth mode on dielectric substrates – on the one hand fabrication of ultrathin smooth silver film and on the other hand preparation of nanostructured silver film.

We have demonstrated that silver film growth can be effectively influenced by the choice of sputtering gas, ie. Ne, Ar and Kr. We studied the influence of RF magnetron power and working gas pressure on plasma composition and properties. The magnetron power was varied from 25 to 100 W. The ambient pressure was changed from 0.5 Pa to 3 Pa. Both mass and OES spectra revealed presence of highly excited plasma in the substrate vicinity for all sputtering gases. The increasing OES signal intensities of Ag and Ag^+ with increasing RF power and gas pressure were observed. However, in Ar discharge there was no Ag^+ signal detected by OES at lower pressures of 0.5 Pa and 1 Pa. Formation of Ag_2^+, $AgNe^+$, $AgAr^+$ and $AgKr^+$ radicals was observed in the mass spectra. A maximum around 19 eV in the ion energy distribution was obtained in Ar and Kr discharges, while the maximum at 28 eV was measured in Ne discharge at pressure of 3 Pa and magnetron power of 50 W. We attribute this effect to higher plasma potential in Ne discharge. Silver thin film deposited in Ne gas revealed roughness of 2.9 nm while the roughness of the films deposited in Ar and Kr gases was 3.9 nm. This can be attributed to higher energy of the atoms and ions impinging the substrate in Ne gas discharge.

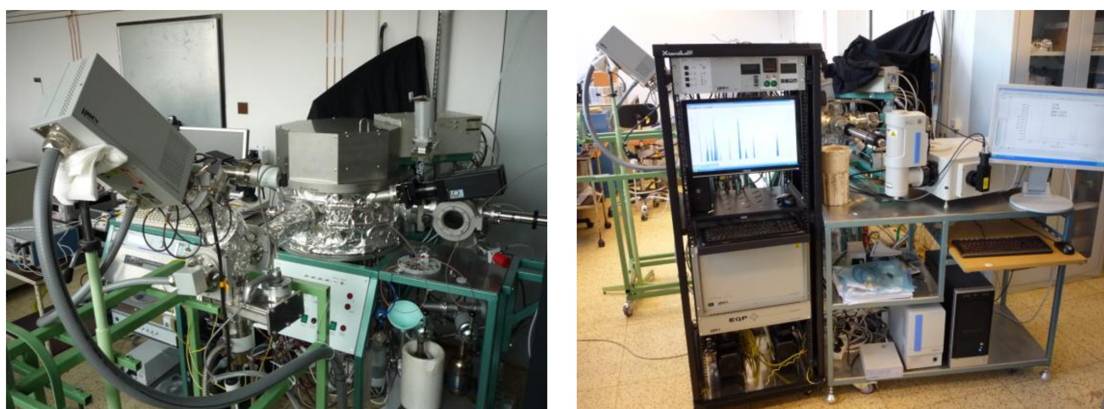

Fig.1 & 2: Experimental setup with a Hiden EQP 500 plasma analyser

Project Summary by:
Michal Novotný,
Institute of Physics,
Academy of Sciences of the Czech Republic,
Na Slovance 2, 182 21 Prague
Czech Republic

Paper Reference:

M. Novotný, J. Bulíř, P. Pokorný, J. Lančok, L. Fekete, J. Musil, M. Čekada (2012) "RF magnetron sputtering of silver thin film in Ne, Ar and Kr discharges—plasma characterisation and surface morphology" *Surface and Coatings Technology,* [online], Available at: http://dx.doi.org/10.1016/j.surfcoat.2012.05.024

Hiden Product:
EQP Mass and Energy Analyser

Follow the link to the product catalogue on our website for further information
http://www.hidenanalytical.com/index.php/en/product-catalog/51-plasma-characterisation/82-eqp-mass-and-energy-analyser-for-plasma-diagnostics

HIDEN ANALYTICAL LTD
420 Europa Boulevard, Warrington, WA5 7UN, England
t: +44 (0) 1925 445225 f: +44 (0) 1925 416518
e: info@hiden.co.uk **w: www.HidenAnalytical.com**