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Electron beam evaporator

BESTEC

Principle

In the evaporation process, vapors are produced from a material located in a source (positively charged anode) which is heated by electron beam (given off by a charged tungsten filament). The process is carried out in high vacuum (10^{-7} to 10^{-8} mbar) so that the evaporated atoms undergo an essentially collisionless line-of-sight transport prior to condensation on the substrate. The substrate is usually at ground potential (i.e., not biased).

Electron beam gun

The impact of a high energy electron beam into a metallic sample offers a clean and high energy density method of heating (compared to resistive and inductive type of evaporators).
In the electron gun, the electrons are produced by hot electron emission from a tungsten cathode (thermionic gun) and are formed to a beam. At the impact point of the sample, most of the electron energy is given up as heat. Thermionic guns have the limitation of a minimum operating gas pressure of about 1.3×10^{-3} mbar [1].

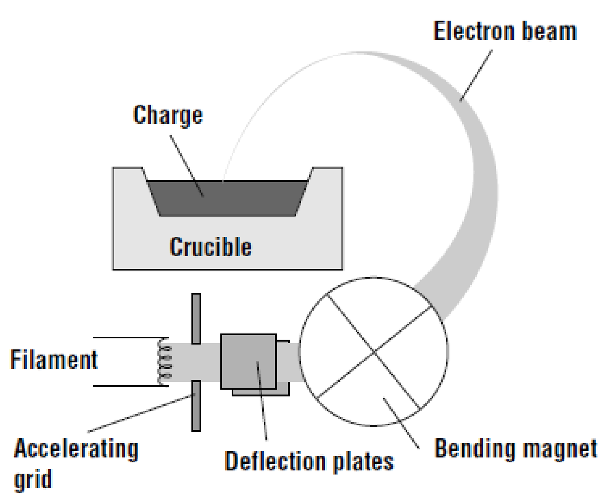
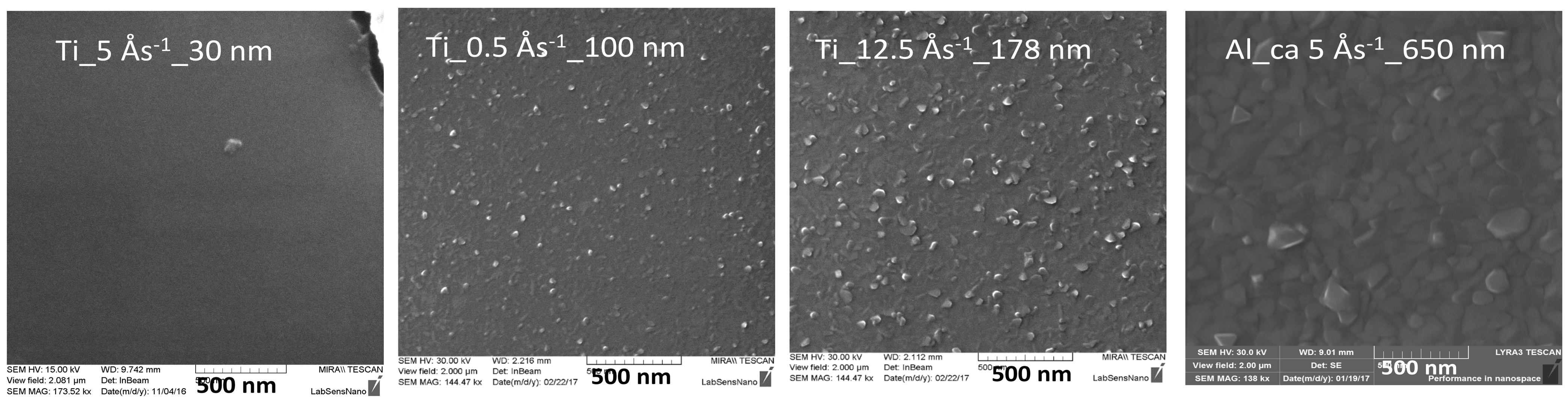


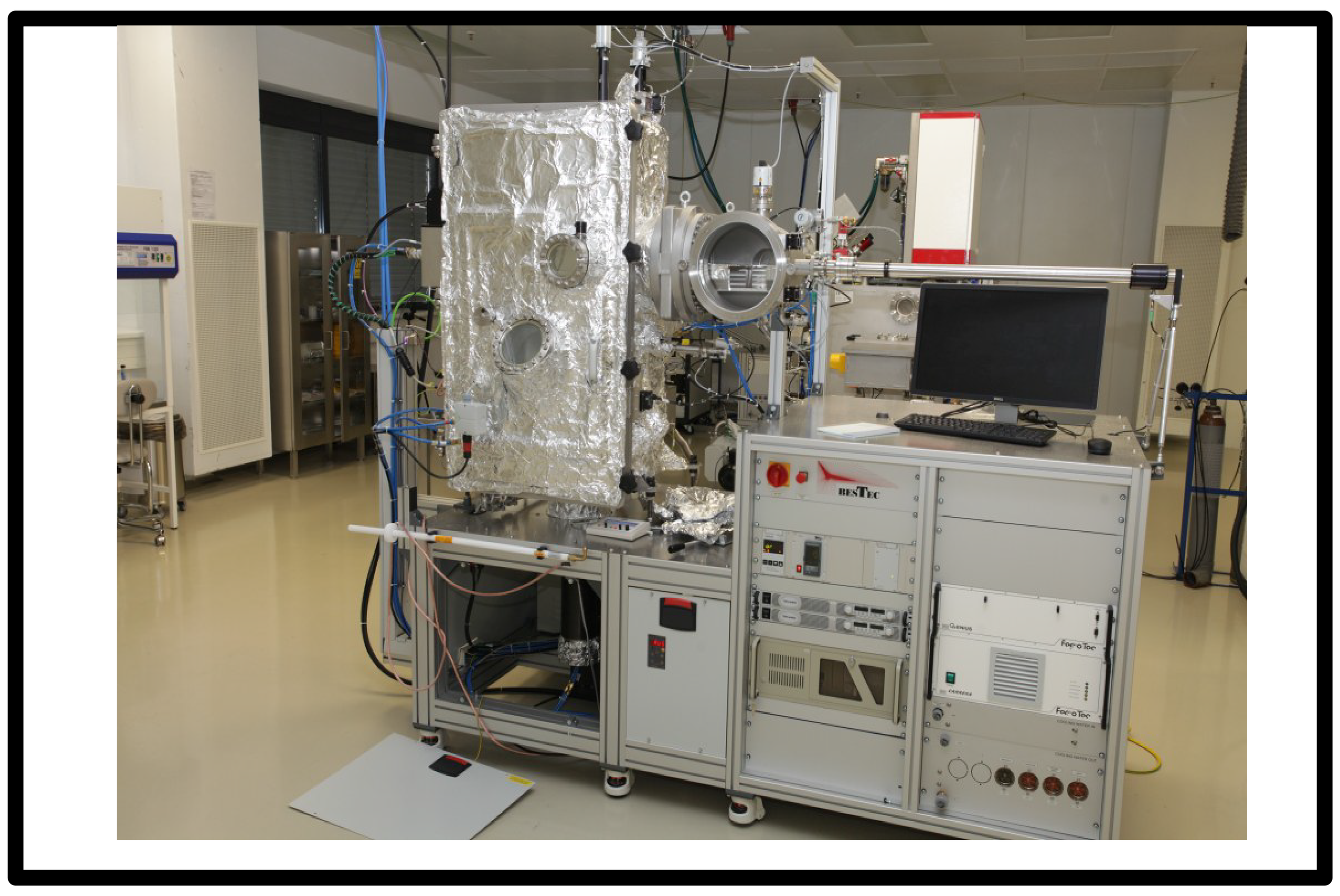
Fig. A popular e-beam evaporative source using a strong magnetic field which bends the beam through 270°. The beam can be rastered across the material to melt a significant fraction of the surface [2].

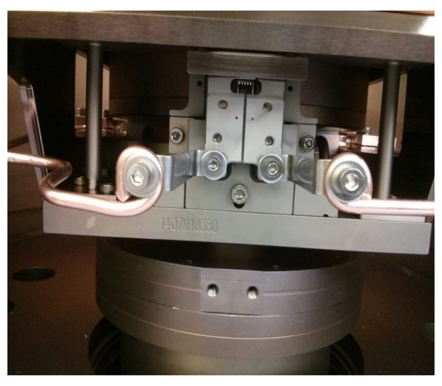
Results

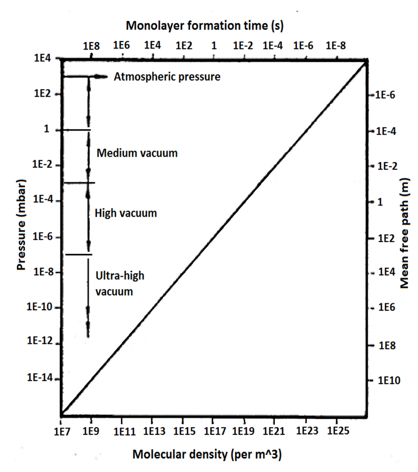
Microstructure depends on:
- nature of the substrate
- temperature of the substrate during deposition (heating up the substrate increases the incident atom mobility and the step coverage of the coating)
- rate of deposition
- deposit thickness
- angle of incident of the vapor stream
- pressure and nature of the ambient gas phase [1]



SEM micrographs of some test depositions made by the e-beam evaporator at the room tempera-ture and different deposition rates (the chamber pressure might vary as well). The deposit thickness is a more crucial parameter than the deposition rate - proven only on Ti layers.







Values of molecular density, mean free path and time to form a monolayer, as a function of pres-sure, for air at 25°C [4] (1 mbar = 100 Pa).

Specification

Accelerating voltage:	up to 10 kV
Power source:	up to 10 kW
Sample size:	7 x 7"
Substrate temp.:	RT-900°C
Max. e-beam intensity:	500 mA

Standard deposition materials:
Au, Ag, Ti, Cr, Cr2O3, Co, Al, Cu, Ni, Fe, CrNi, NiFe

Publications

[1] R.F. Bunshah: Handbook of Deposition Technologies for Films and Coatings, Noyes Publications, New Jersey, 1994
[2] S.A. Campbell: Fabrication Engineering at the Micro- and Nanoscale, Oxford University Press, Oxford, 2008
[4] N.S. Harris: Modern Vacuum Practice, McGraw-Hill, London, 1989
[] K. Fabiánová: Fabrication of well defined nanoporous structures with application in membrane sensing, Bachelor´s thesis, 2016. (Ceitec publication)

More info

Guarantee: Marek Eliáš (marek.elias@ceitec.vutbr.cz)
Web: http://nano.ceitec.cz/electron-beam-evaporator-bestec/