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VACUUM DEPOSITION SYSTEM FOR ION–BEAM–ASSISTED COATING TECHNOLOGIES

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Ion-beam-assisted deposition (IBAD) is increasingly used in thin film technologies to solve problems of adhesion, stress inside layers or to generate special properties of surfaces of solids. A small size IBAD system for use in research laboratories or for industrial use is described. The vacuum system uses a wide range turbomolecular pump and a diaphragm backing pump. The oil free system has a general advantage for thin film technologies. One or more planar magnetrons and a filamentless ion source are arranged in a cylindrical vacuum chamber. The system can be extended by additional chambers for loading, plasma cleaning and unloading. A computer control allows automatic coating procedures or manually controlled actions.

1. Introduction

Ion-beam-assisted deposition (IBAD) is a combination of two physical processes in high vacuum: ion implantation and physical vapour deposition (PVD). Ions of high energy are accelerated by electrical field and are “implanted” into the lattice structure of the surface. They substantially alter the properties of the treated area.

The result is an "micro alloy" of basic material with ion material. Well known PVD process is done by sputtering from a planar magnetron.

IBAD unites advantages of both technologies. Atoms of sputter- deposited material are bombarded by ion beam, therefore also implanted into the surface. It means a superior adhesion of coating by gearing together the substrate and the sputtered material.

IBAD process generates surface layers with strong adhesion, high density, less stress, and allows interesting combinations of sputtered material and ion material. The ion beam is also a tool to generate special surface modifications. Diamond-like carbon coatings is an example for this process.

2. IBAD deposition system

A small–sized vacuum deposition system for the research of coating processes and their industrial applications has been developed.

The axis of the cylindrical vacuum chamber of a standard diameter of 320 mm is positioned horizontally. Therefore, the door flange and the rear flange may be substituted easily by separate chambers for loading, plasma cleaning and other in-line processes.

Small dimension allows a cost effective deposition of single layers in short coating cycles. An oil-free pumping system was designed to eliminate possible contamination of deposited layers with hydrocarbone molecules. The system is pumped with a wide-range (Hollweck) turbomolecular pump and a diaphragm pump as the backing pump. The main vacuum chamber is equipped with one or more magnetrons and with an ion source. Magnetrons of up to 8" diameters may be used. The filamentless ion source is usable also for reactive processes. Ion beam process acts on an area of 25 cm^2. A corresponding motion of the sample (lateral or rotation) is, therefore, necessary.

Sample can be mounted either on a rotation manipulator or on a water-cooled flat table. Vacuum system, deposition process and sample handling are controlled by an internal computer system (PLC). A touch screen operation on the colour display allows control of the vacuum system, deposition process and sample motion. The deposition cycle may be done automaticaly on receipt for production processes with short batch times or by manual interaction for research and development.

3. Applications

The IBAD is applied for diamond like carbon coating (DLC), reactive coatings (hard layers) and no-reactive deposition (metallization of plastics). The main advantage of IBAD process is the high adhesion, reduced stress of layers and the possibility of surface engineering. Therefore, IBAD coatings allow high quality depositions, where conventional PVD coatings fail.

TABLE 1.
Specification of the magnetron and ion source.

Magnetron 1: 8"	Magnetron 2: 4"	Ion source: 2", filamentless
DC	DC	Anatech pat.
10 kW	6 kW	5–1200 eV

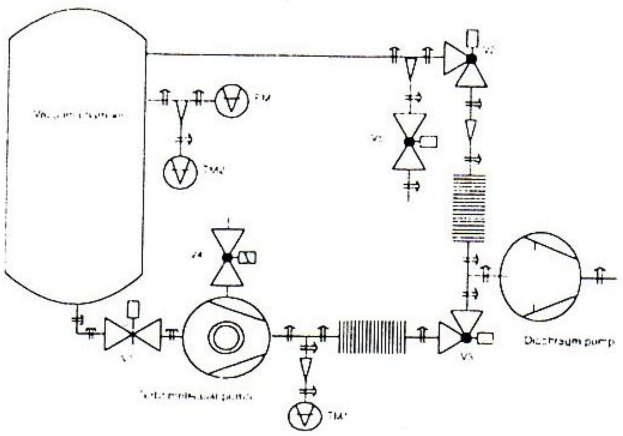

Fig. 1. Schematic diagram of the vacuum system.

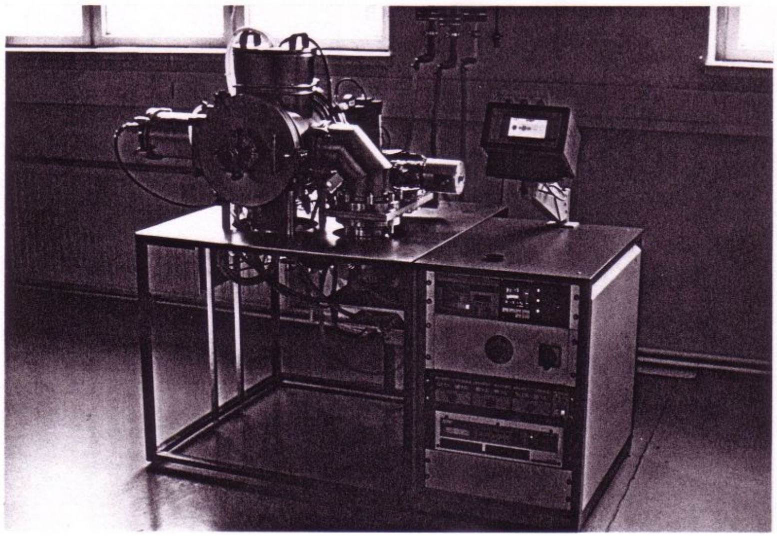

Fig. 2. Complete IBAD system with planar two magnetrons (top and bottom) and ion source (left).

TABLE 2.
Technical data on the vacuum deposition system.

Technology	Plasma cleaning (optional) Ion etching Magnetron sputtering Arc-evaporation (optional) Ion-beam-assisted deposition (IBAD) other methods optional
Coating systems	Hard coatings (TiN, ZrN, CrN, TiAIN, TiCN and other) Metallic thin films (Au, Pt, Ag, Cu, Al, Mo, Ti, Cr and other Ceramic coatings (Oxides and Nitrides)
Vacuum chamber	Stainless steel, cylindrical shape, water cooling available Nominal size 320 mm/12.5". One or multiple chambers, separated by gate valves Axial support for parts, sample stage $\approx$ 250mm $\times$ 300 mm (10"$\times$12") Maximum size of goods: flat substrates appr. ϕ 200 mm, cylindrical parts appr. ϕ 100mm $\times$ 250 mm
Vacuum system	Wide range turbomolecular pump Balzers TMH 520 Diaphragm pump (oilfree) Vacuumbrand MD 4T Vacuum control PLC system Residual pressure $< 10^{-5}$ mbar, processing pressure 10^{-1} to 10^{-15} mbar.
Computer control	OMRON - PLC Automatic processing on receipts and/or interactive manual operation via LCD-touch screen
Dimension, weight	Single chamber system appr. 1500mm $\times$ 1100mm $\times$ 1600 mm, appr. 500 kg.

SUSTAV ZA VAKUUMSKO NAPARAVANJE UZ POJAČANJE PREKRIVANJA IONSKIM SNOPOM

Radi rješavanja problema prianjanja, naprezanja u slojevima ili radi postizavanja posebnih efekata, sve se više upotrebljava nanošenje uz pojačanje ionskim snopom. Opisuje se takav malen sustav za primjenu u istraživačkim laboratorijima ili u industriji. Vakuumski sistem isisava pumpa s dijafragmom i turbomolekulska pumpa, što omogućava rad bez zagadenja uljem. U cilindričnoj komori mogu se razmjestiti jedan ili više magnetrona i izvora iona. Moguće je automatsko vodenje procesa naparavanja računalom.