Fraunhofer
FEP

Fraunhofer Institute for
Organic Electronics, Electron Beam
and Plasma Technology FEP

Double Ring Magnetron DRM 400

High-rate sputtering with superiour process control

DRM 400 on cluster plant

Integrated package with DRM 400

Double Ring Magnetron – DRM 400

High-precision coatings are required for a wide range of applications in the area of optics, electronics and sensor technology.

Stable and homogenous processes at high rates are a prerequisite and demand dedicated components.

At Fraunhofer FEP we have developed a Double Ring Magnetron DRM 400 that can be integrated, e. g. in cluster-type plants for substrate sizes of up to 300 mm. For more demanding homogeneity requirements and/or larger sizes, concepts for further scaling via multi ring sources are available.

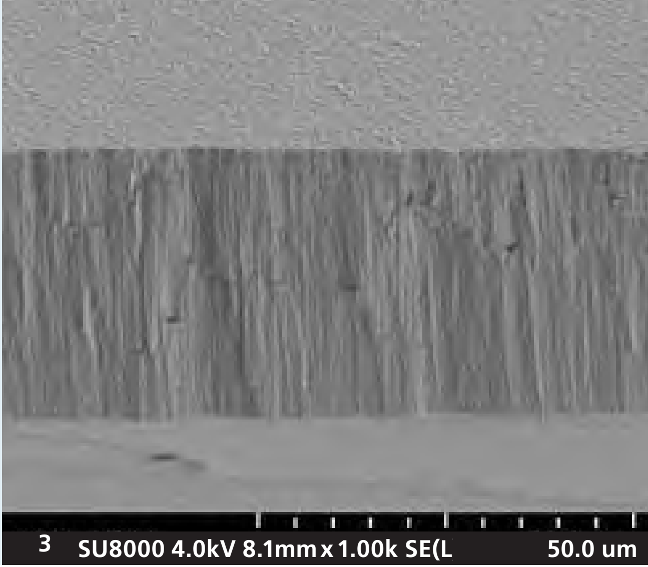
Individually controllable concentric plasma discharges from the inner and outer ring target enable layer thickness homogeneities of up to ± 0.5 percent (for substrate sizes of 8˝/200 mm).

At the same time, innovative control concepts open new processing options such as the reactive deposition of ceramic layers (oxides, nitrides) with excellent process control at superior rates as well as gradient layers by changing the composition of the reactive gas during the coating process.

Various powering options including the transition between them allow for the controll of the growth energetics for adjustements of density, orientation and phase, while mechanical stresses can be mitigated.

Hardware

- DRM sputter source with integrated
  - gas distribution system
  - electrically insulated inner and outer targets
  - individually adjustable magnet systems
  - long-term efficient hidden anode
  - reactive gas control
  - optical emission detector (OED)
- DC, MF pulse or RF powering according to application
- MF powering in different pulse modes (unipolar, bipolar or unipolar/bipolar hybrid) for adjustment of energetic growth conditions
- Process management computer
- RF bias, RF ion etching capabilities available
- Measurement and control devices for
  - inert and reactive gas flow
  - process pressure
  - optical plasma emission
  - magnetic field strength at target surface

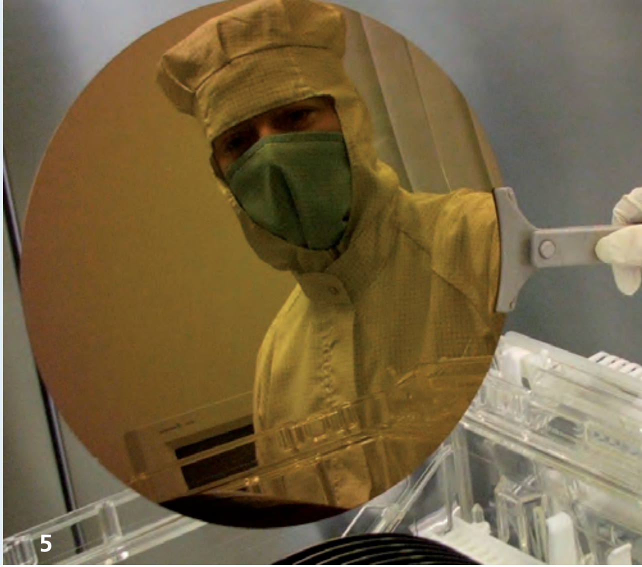


Deposition of 50 µm AlN demonstrates high deposition rate and superior stress control

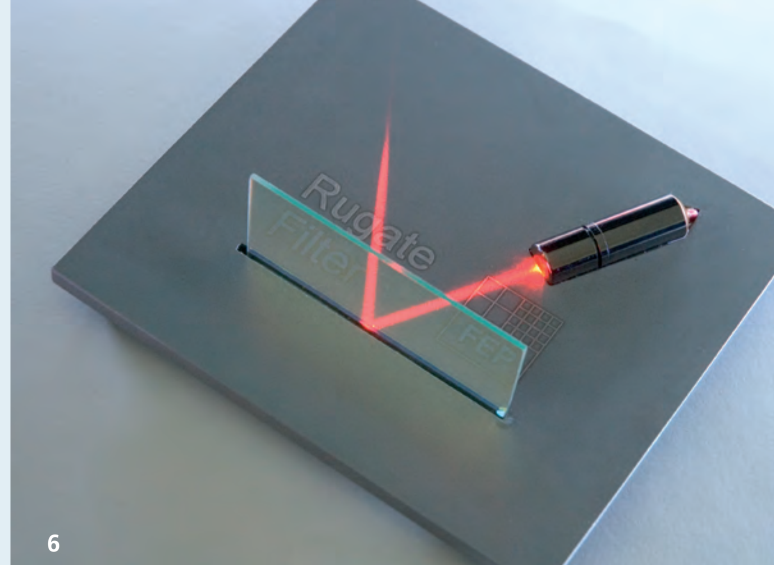
View into the clean room

DRM-type magnetron sputter sources

Substrate
Shielding
Inner target
Anode
Outer target
Flange
N S N S N S N S
Outer magnet system
Inner magnet system
Unipolar pulse mode
Bipolar pulse mode
UBS-C2
DC power supplies



Functional coating on 300 mm wafer



Rugate filter

Process control and technology

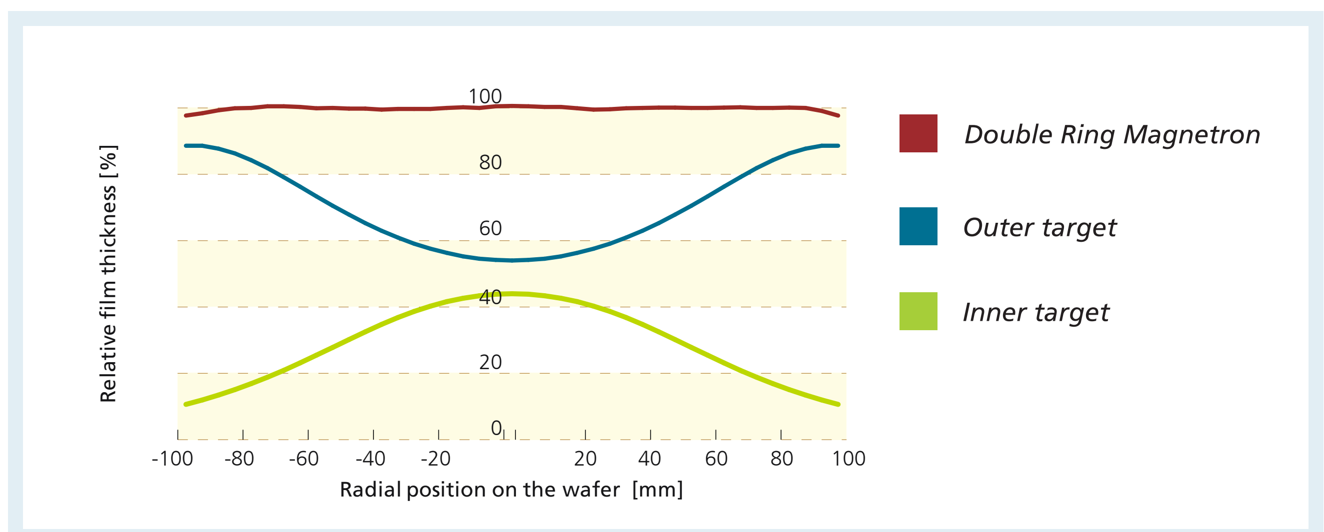
- Computerized automatic receipe controlled coating process
  - stabilization of reactive process for high-rate and long term stable processing
  - magnet adjustment to compensate target erosion
  - control and adjustment of powering
  - gas management and pressure control
- Variation of reactive gas composition during deposition
- Pre-programmed recipes for a variety of coating applications
- Communication to host computer for fully automatic control of the sputter system
- Remote control for support, service and software upgrade

Our offer

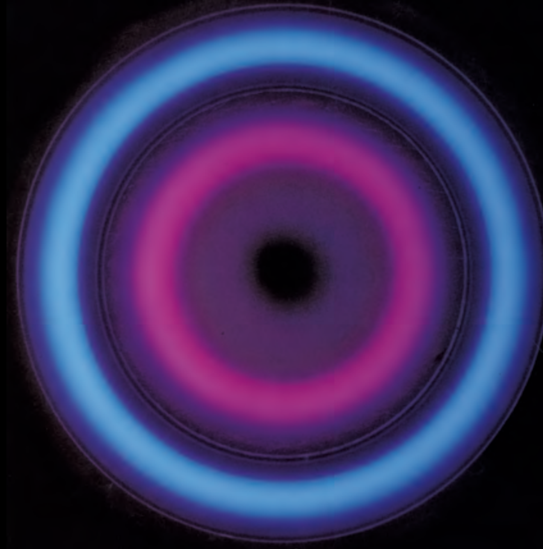
- Application-oriented process development of layer systems for customer specific requirements
- Feasibility studies
- Technology packages with process development and key components
- Technology transfer
- Retrofit of coating equipment (Magnetron, Powering, Process Control)

Applications

- Optical coatings
- Piezoelectric layers
- Electrical insulation films
- Passivation, protection and barrier layers
- Functional oxide coatings



Superposition of film thickness contributions from inner and outer discharge ring

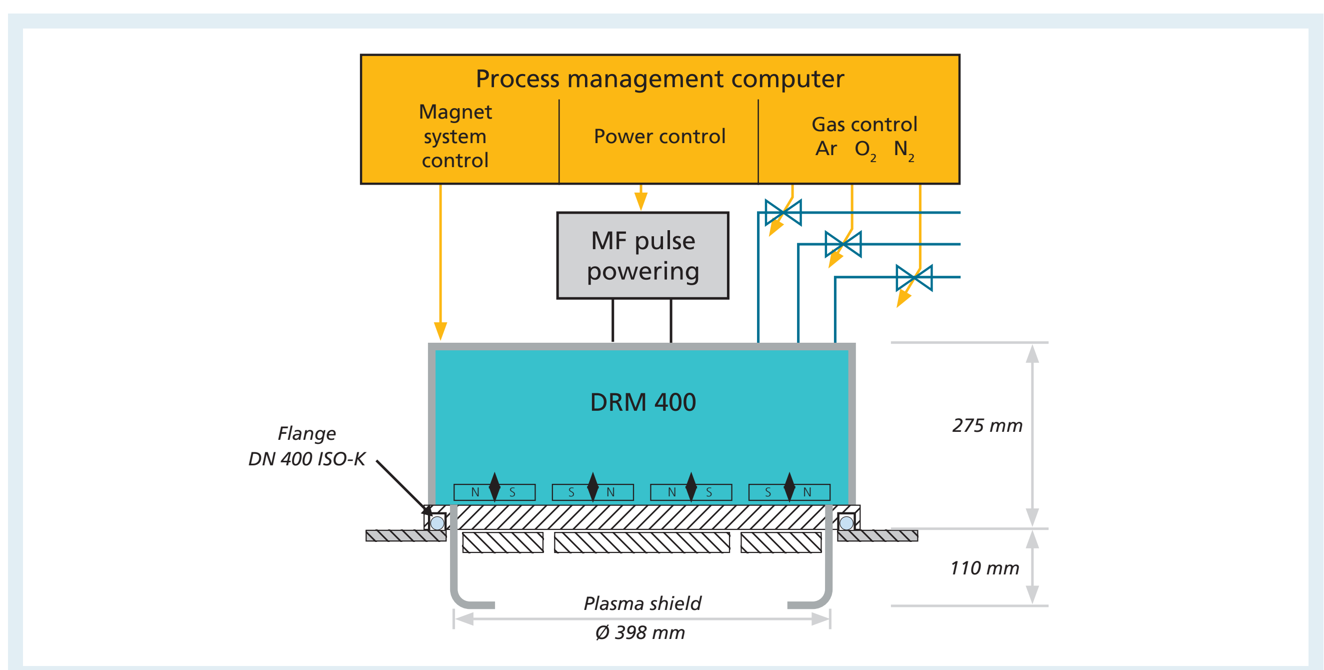


Plasma generated by a double ring magnetron

Different target materials for the inner and outer targets enable combinatorial materials development.

DRM 400 – Typical layer materials

Type of layer	Examples	Deposition rate [nm/s]
Metals	Al, Cr, Cu, …	15 ... 25
Alloys	Ni/Al, NiV_7, …	10 ... 15
Binary compounds	Al_2O_3, AlN, AlF_3, SiO_2, Si_3N_4, TiO_2, Ta_2O_5, Nb_2O_5, TaN, HfO_2, …	2 ... 4
Ternary compounds	$Si_XO_YN_Z$, $Al_XO_YN_Z$, $Si_XTa_YO_Z$, $Al_XSi_YO_Z$, $Al_XSc_YN_Z$	2 ... 4
Gradient layer system	$SiO_2 \rightarrow Si_XO_YN_Z \rightarrow Si_3N_4$ $Al_2O_3 \rightarrow Al_XO_YN_Z \rightarrow AlN$ $SiO_2 \rightarrow Si_XTa_YO_Z \rightarrow Ta_2O_5$	2 ... 4
Functional oxides	$BiFeO_3$ (BFO), $BaTiO_3$ (BTO), $SrTiO_3$ (STO), ITO	0.2 ... 2



Integrated package with DRM 400

Contact

**Fraunhofer Institute for Organic Electronics,
Electron Beam and Plasma Technology FEP
Winterbergstr. 28
01277 Dresden, Germany**

Contact
Dr. Hagen Bartzsch
Phone +49 351 2586-390
hagen.bartzsch@fep.fraunhofer.de

Dr. Jörg Neidhardt
Phone +49 351 2586-280
joerg.neidhardt@fep.fraunhofer.de

www.fep.fraunhofer.de

Follow us!

We focus on quality and the ISO 9001.

Picture credits

Title: Rolf Grosser
Anna Schroll: 1, 4
Fraunhofer FEP: 2, 3, 6, 7
Finn Hoyer: 5