

Thin film deposition, structuring and analysis on wafer level (200 mm)

*View of the vacuum coating tool
in the cleanroom*

Fraunhofer IPMS disposes of a wide array of processes available under cleanroom condition. The equipment is geared to the development and manufacturing of OLED microdisplays. The main focus lies on the deposition and structuring as well as the patterning of organic and inorganic layers from the nm up to the μm range. Several tools and processes are available for this purpose. In addition, we offer analytical methods for thin film characterization.

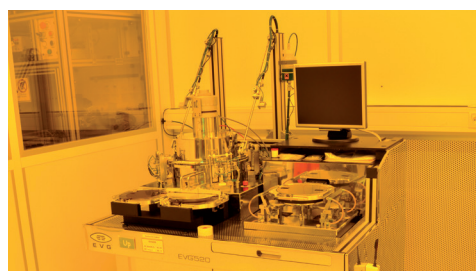
Processes, technologies and equipment under cleanroom condition ISO 5

At Fraunhofer IPMS we have the opportunity to combine different processes and tools. Layer and layer stacks can be thin film encapsulated to protect them from moisture and oxygen, if needed.

We can also combine evaporated and spin-coated materials with various anode/cathode materials to be finally encapsulated and structured on pilot line quality.

Another highlight is the alignment accuracy of $\pm 10 \mu\text{m}$ for shadow masks during layer deposition and argon etching.

Besides layer deposition and structuring, the bonding of wafers and substrates is an important process. Color filter wafer can be aligned with an accuracy of $\pm 1 \mu\text{m}$ and bonded under vacuum. In addition, there are processes for temporary bonding available.



Wafer bonder EVG 520 IS

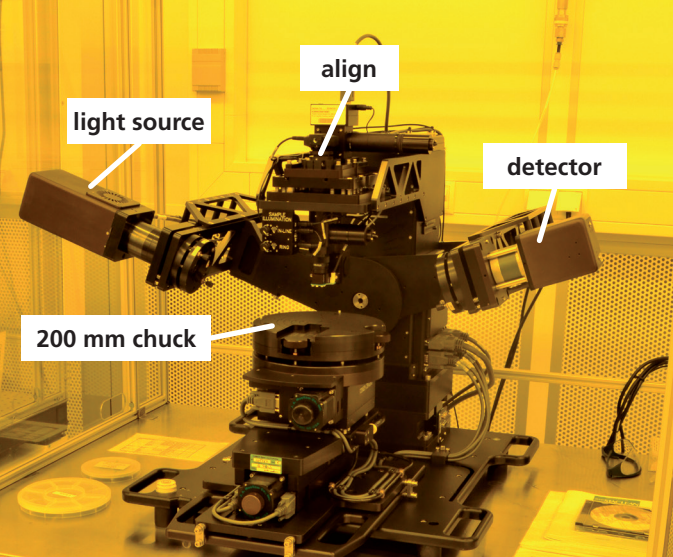
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Left: WOOLLAM M-2000F ellipsometer for thickness measurement of thin films and determination of optical constants

Middle: Mask aligner EVG IQ-Aligner for wafer alignment with $\pm 1 \mu\text{m}$ accuracy

Right: Particle measurement tool Surfscan 7700 for particle and particle density measurement considering the local distribution

Deposition of single layer and layer stacks

Deposition of single layer and layer stacks with a thickness of $\geq 1 \text{ nm}$ on max. 200 mm silicon or glass wafer or also on foils:

- Organic materials, especially organic semiconductors from solution, e.g. polymers (PEDOT:PSS, P3HT) or from gas phase (e.g. Alq₃, C60, Phthalocyanines)
- Metals (e.g. Ag, Ca, Al)
- Metal oxide compounds (e.g. MoO_x, AlO_x, SiO_x, TiO_x)
- Thin film encapsulation by Barix multilayer/ Vitex process (WVTR $< 10^{-5} \text{ g/m}^2\text{d}$)

Tools:

- Vacuum evaporation in high vacuum
- Electron beam evaporation
- Fully automatic magnetron sputtering system with process gases like Argon, Oxygen and Nitrogen
- Spin coating using dye markers

Particle measurement

Particle measurement tool Surfscan 7700 by KLA-Tencor

- Analysis of structured and unstructured wafers
- Detection of defects/particles $\geq 0.15 \mu\text{m}$
- 30 mW Argon ion laser, wavelength: 488 nm
- Variable input polarization

Structuring of layers by:

- Shadow masks
- Dry etching with Argon and/or Nitrogen in combination with 1:1 lithography

Bonding

Wafer Bonder (EVG 520):

- Substrates: typical 150/200 mm wafer, substrate stacks up to 9 mm
- Mechanical pressure: 0 – 40 kN
- Chamber gas: vacuum 10^{-3} mbar , N₂, other gases by request
- Voltage/current: 2 kV/50 mA
- Room temperature up to 550 °C
- Bond processes: adhesive, fusion, eutectic, anodic

Mask Aligner (EVG IQ-Aligner):

- Substrates: 150/200 mm wafer, typical thickness 0.5 up to 6 mm
- Alignment accuracy: $\pm 1 \mu\text{m}$ (top and bottom side align)
- UV exposure: 365 nm, 20 mW/cm², 5% uniformity
- Customized alignment marks
- Available processes: bond align, IR align, wafer stack align, mask align

Automatic Spin-/Spray-Coater + Bonder + Aligner (EVG Hercules):

- Wafer encapsulation for 200 mm wafers
- Coat (spin/spray), bake, cool, bond, align, expose

Photo lithography

Substrate size: 200 mm wafers (typ.)

Tools:

- Brewer Spincoater for photo resist deposition
- Laurell spincoater in glovebox (dry N₂ atmosphere)
- EVG wafer aligner/exposure system
- Leybold Optics vacuum cluster for dry etching via O₂-RIE and Ar-ion mill)

Electro-optical tests

Ellipsometer WOOLLAM M-2000F

- Spectroscopic ellipsometry at 1 nm up to 25 nm thin layer
- Wave length range: 245 – 1000 nm
- 200 mm wafer chuck, smaller samples possible
- Fully automated stage (x, y, z)
- Automated alignment (Align 200)
- Option: 50 μm focusing probes

Filmetrics F50

- Reflectometer: measurement at 30 nm up to 50 μm thick layers (wavelength range 380 – 1050 nm)

Electro-optical characterization (Wentworth wafer prober)

- Luminance-Current-Voltage (LIV)-measurement on 200 mm wafer level
- Automatic wafer and chip measurement using probe cards