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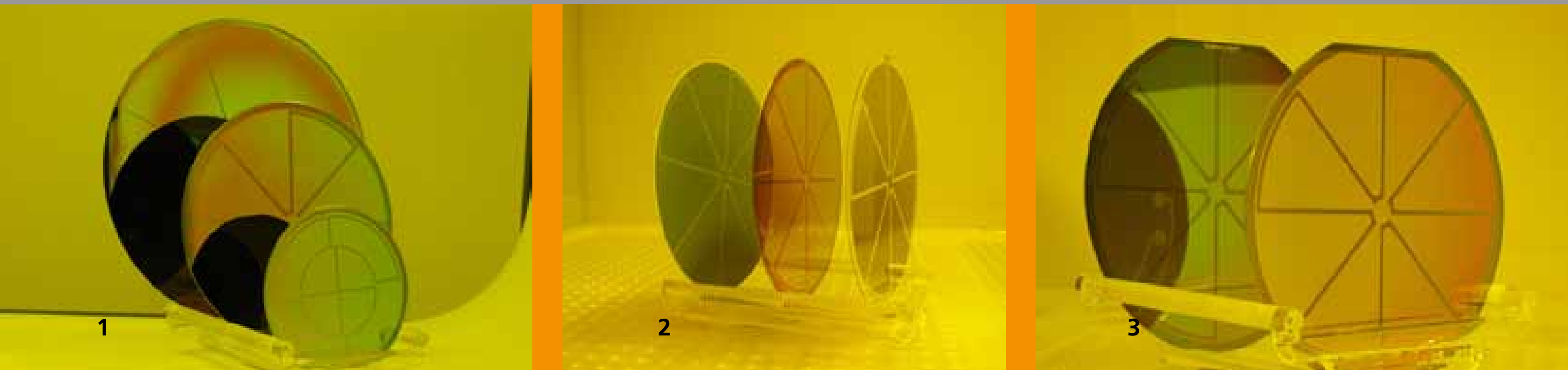
FRAUNHOFER RESEARCH INSTITUTION FOR MICROSYSTEMS AND SOLID STATE TECHNOLOGIES EMFT



1 *e-carrier (front side)*
2 *e-carrier: ceramics, silicon and glass (from left to right)*
3 *e-carrier*

MOBILE ELECTROSTATIC CARRIER „E-CARRIER“

Applications

Current technological trends require more and more flat microelectronic devices. New handling technologies are crucial to handle the extremely thin and fragile wafers. The patented mobile electrostatic carrier developed by Fraunhofer EMFT allows for an easy and safe handling of ultra-thin semiconductor wafers for diverse applications such as:

- Manufacture of energy efficient semiconductors: Power devices, opto-electronic devices (LED) , solar cells
- Portable electronics requiring extremely flat packages: cell phones, tablets, wearables
- Ultra-thin integrated circuits (IC), stacked devices, 3D Integration
- Flexible electronics: sensors on curved surfaces, hybrid systems-on-foil
- Plasma dicing of ultra-thin wafers

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Technical Innovation

- Secure handling and processing of thin wafers or film substrates by electrostatic forces
- Temporary bonding without adhesives, elimination of costly cleaning steps
- Size and form of the e-carrier correspond to a standard wafer; modifications of equipment are not necessary
- Electrostatic clamping remains active after undocking the power supply
- The silicon e-carrier is also suitable for high temperature processes

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Panasonic

State of Development

Mobile electrostatic carriers can be prepared by various technologies and in practically any size or form. For handling and processing of thin semiconductor wafers the use of wafer sized substrates is preferred. There is no need for costly adaptations of existing wafer handling systems. In order to enable handling of larger substrates like for instance sheets of flexible films other substrate technologies (e. g. printed circuit boards or glass panels) can be used as well. This allows for significant cost reduction. At Fraunhofer EMFT, e-carriers were already used for processing of thin or flexible substrates in various process modules.

We prepared and evaluated three demonstrators:

- **Using silicon wafers as support substrate:**
  In this case preparation steps were done in a semiconductor manufacture environment using very thin and high performant insulation layers, e. g. thermal silicon oxide or plasma deposited silicon nitride layers. Such process technologies allow for strong electrostatic forces even at low voltages and also at temperatures above 300 °C. Furthermore, silicon based e-carriers show optimum compatibility with CMOS production facilities.
- **Using glass wafers as support substrate:**
  In this case polymeric insulation layers (e. g. polyimide films) were applied onto wafer sized glass substrates. Manufacture technology allows for rear side contact pads at low cost. As we used thicker insulation layers the e-carriers require higher clamping voltages. Beneficially, this leads to less sensitivity to surface properties of the clamped substrates. In a cooperation with the company **Panasonic** glass-based e-carriers have been successfully applied in the process module "thin wafer lithography" in the clean room of Fraunhofer EMFT.
- **Using epoxy boards as support substrate:**
  In this case standard low cost manufacture technologies well known from printed circuit board (PCB) industry was used for preparation of e-carriers. PCB based e-carriers are well suited for handling of flexible film substrates (PET, PEN, PI) of practically any size. We demonstrated a soldering process on a sheet of polyimide film (FPC: Flexible Printed Circuit) using a reflow oven at Fraunhofer EMFT. Also this project work was done in cooperation with our partner **Panasonic**.

Based on our long term experience and IP background the Fraunhofer EMFT staff offers design and manufacture of application specific e-carriers for customers.

Outlook

We see a wide spectrum of potential use cases for industrial applications of mobile electrostatic carriers for handling and processing of thin or flexible substrates. Current focus of research work at Fraunhofer EMFT is on the development of e-carriers that are robust to processing environments that formerly would have led to unwanted discharge of electrodes due to leakage currents or conductive environments. These new (yet undisclosed) technical features offer the chance for secure wafer processing in plasma processes, wet-chemical environments or high temperature ovens without the risk of loosing wafers in a production line (fail safe operation).

1 *Use of e-carriers in spin-coating and development of photoresist on very thin wafers.*
2 *Rear side of a glass e-carrier showing recessed contact pads for charging and discharging*