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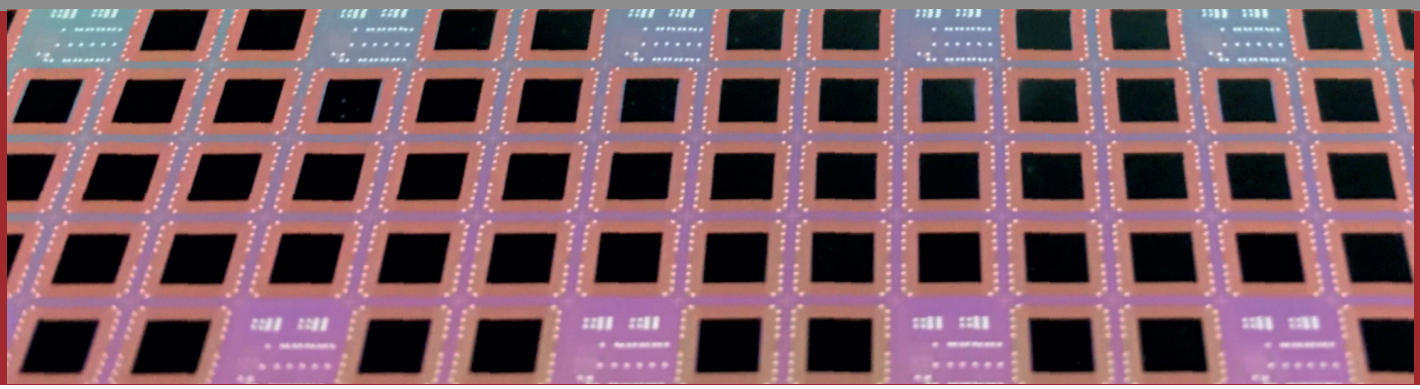

FUNCTIONAL CNT FILMS – ABSORPTION LAYERS FOR IR APPLICATIONS

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In cooperation with

ZfM Zentrum für Mikrotechnologien

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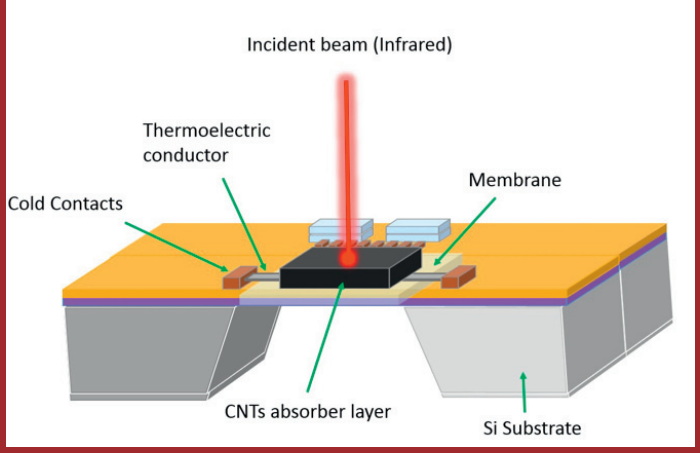
Next generation of micro optical infrared (IR) sensors require advanced absorbers which fulfil tough technological and material requirements. Current solutions considering materials such as black metals, filled polymers or λ/4 type layers are limited in absorption level, spectral range, heat capacity, mechanical instability and technology compatibility. A promising alternative represent directly integrated carbon nanotubes (CNTs) as absorption layers. Carbon nanotubes have the potential to overcome the mentioned limitations by offering high wavelength independent absorption capability and good thermal and mechanical properties at the same time. We offer wafer scale processes for integration of functional CNT layers in sensoric and electronic application. Thereby we provide solutions and developments reaching until the system level.

Available optical CNT-based absorber technology:

- Scalable wafer-scale process in ISO 4 cleanroom environment
- CVD growth of vertically aligned CNTs at process below 500 °C
- Structured growth
- MOEMS compatible integration technology for IR-absorbers and -emitters
- Growth on metallic and dielectric supports
- Process development service for customized layer configurations



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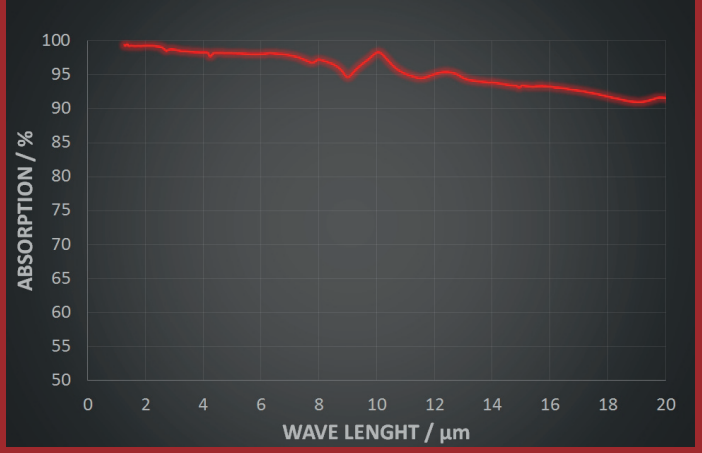

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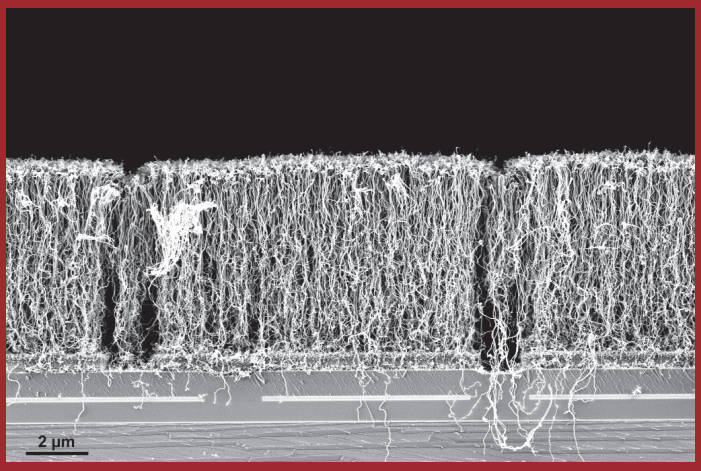

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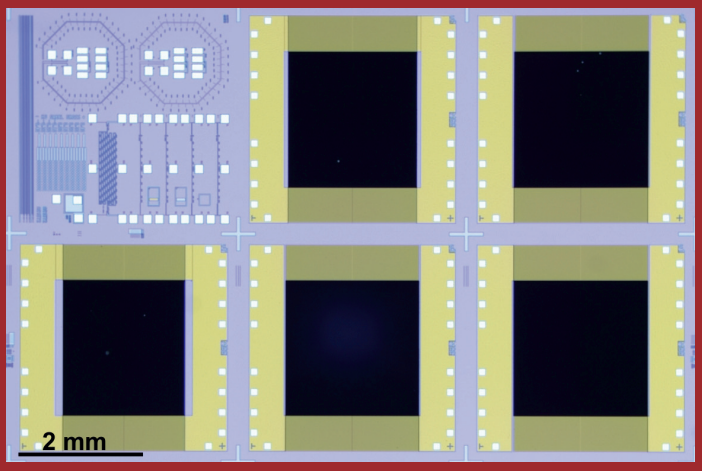

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Advantages at a glance:

- High broadband absorption: above 95 % for λ = 2 … 12 µm and above 90 % for λ = 2 … 20 µm
- Temperature-stable up to 500 °C in N_2 atmosphere
- Good thermal conductivity and low density → low thermal mass for high speed sensors
- High technological compatibility: MEMS, MOEMS, CMOS

Possible Applications:

- Anti-reflective coatings
- Absorption layers for thermal IR sensors (Thermopiles, pyro detectors, e.g. for gas detection and thermography)
- Black layers for IR emitter (gas detection, e.g. for area monitoring, medicine and safety equipment)

1 Schematic of a MEMS based infrared sensor or emitter with carbon nanotube as absorption layer as possible application.

2 Absorption behavior of CNT layers grown at temperatures below 500 °C.

3 SEM cross section of CVD layers grown at temperatures below 500 °C and integrated in a sensor structure (heater layer can be seen under the CNTs).

4 Microscope image of patterned CNT absorption layers.

Property \ Absorption layer	Ultra thin metal layers	Black metal layers	Filled polymeres	λ/4 layers	Carbon Nanotubes
Absorption	< 50 %	98 %	90 %	n/a	> 95 %
Wavelength dependency	–	+	o	––	+
Thermal conductivity	+	+	–	–	+
Integrability	+	–	+	+	+

Table: Important layer properties for IR sensors – Comparison and qualitative rating for carbon nanotubes and other common absorption materials.