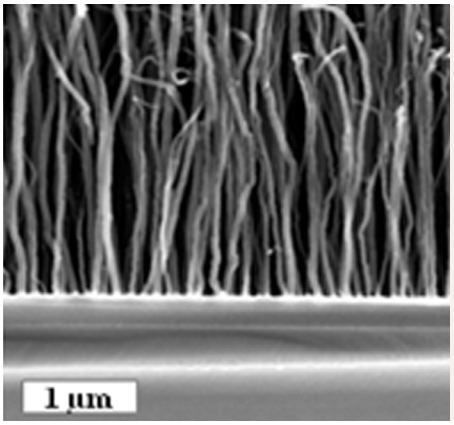
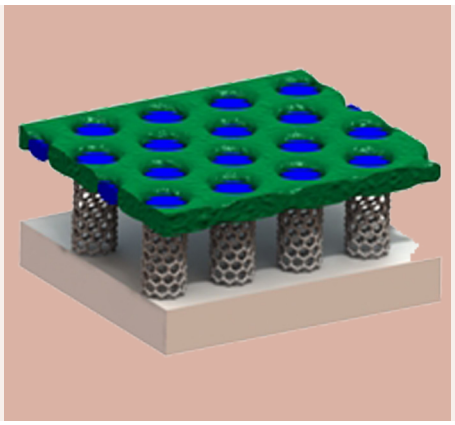
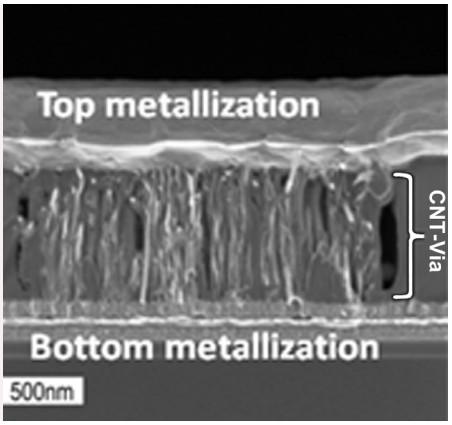
INTEGRATION OF CARBON NANOTUBES AND APPLICATIONS







Contact

Fraunhofer Institute for Electronic Nano Systems ENAS
Technologie-Campus 3
09126 Chemnitz | Germany

Contact persons
Prof. Dr. Stefan E. Schulz
Phone: +49 371 45001-232
Email: stefan.schulz@enas.fraunhofer.de

Dr. Sascha Hermann
Phone: +49 371 45001-292
Email: sascha.hermann@enas.fraunhofer.de

CNT Integration and Application

Focus of our group is the integration of carbon nanotubes with wafer level techniques for electronic and sensor applications. It can be subdivided into process development for growth as well as assembly of CNTs and development of application specific fabrication technologies for CNT devices.

(1) Chemical vapor deposition (CVD)

Process developments focus on the controlled growth of CNTs at 400 to 650 °C, a good electrical CNT-metal interface and a waferlevel scale integration of CNTs under application specific constraints. Our process portfolio contains growth of vertically aligned multi-walled CNTs (e.g. Fig. left) with single metallic or bi-metallic catalysts on dielectric and metallic underlayers. For patterned CNT growth, we can provide an underlayer controlled site-selective catalyst activation approach. Additionally, a novel growth approach for CNT films (Fig. Center) allows us to switch easily between the different CNT growth modes and to apply new integration approaches for CNT films.

(2) Dielectrophoresis (DEP)

The technique is used to selectively deposit and align CNTs at room temperature. The method was systematically developed further to obtain a wafer scale technique. Our R&D activities focus on the preparation of CNT dispersions with restricted electrical and dimensional properties of single-walled CNTs, site-selective deposition of horizontally aligned CNTs and reliable electrical/mechanical CNT-metal contact formation. The process developments aim a seamless integration technology for the realization of CNT-based NEMS applications.

(3) CNT applications

- Flexible electrical CNT interconnects for flip-chip applications
- CNTs as vertical interconnects for next generation interconnects in ULSI circuits
- Development and fabrication of nanotestplatform for characterization of nanomaterials
- CNT based electro-mechancial transducers with different working principles
- CNT transistors

Fraunhofer ENAS
ZfM Zentrum für Mikrotechnologien
CHEMNITZ UNIVERSITY OF TECHNOLOGY

Available equipment:

- 100 mm single wafer tool for thermal CVD of CNTs
- Roth&Rau 200 mm multi-chamber tool for in-situ processing and batch production
  - CVD reactor for growth of CNTs and graphene with plasma assistance and in-situ Raman
  - IBSD reactor for thin layer deposition
  - 2 x ALD reactors for deposition of thin metal and dielectric films
  - In-situ XPS for chemical analysis
- 150 mm single wafer tool for wafer level dielectrophoresis of CNTs
- Renishaw Raman spectrometer (in-situ/ex-situ)
- Nanomanipulator for manipulation and electrical characterization of nanomaterials in SEM
- Chemical laboratory with centrifuge, sontrode, glove box etc. for nanomaterial handling and preparation