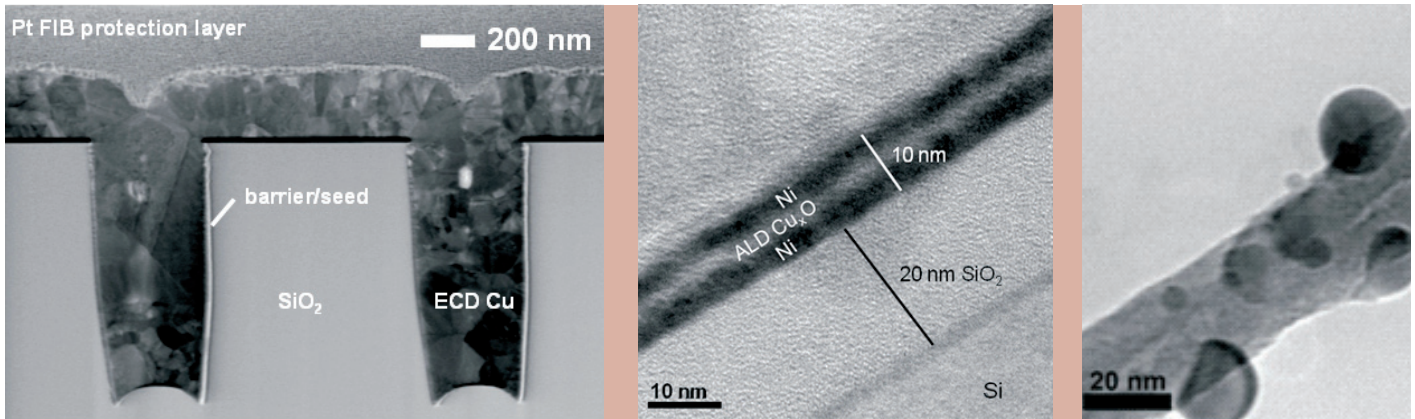


ATOMIC LAYER DEPOSITION AND TARGETED APPLICATION AREAS



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Figures:
STEM image of ECD Cu fill on a TaN/Ru stack prepared by PVD with Cu seed deposited by ALD. (left); ALD copper oxide integrated with sputtered nickel films. (center); Functionalization of carbon nanotubes by ALD. (right)

Available Equipment

- 100 mm single-wafer tool with 2 liquid delivery systems and 2 bubblers
- Roth & Rau 200 mm multi-chamber tool with two ALD chambers, each with:
 - 2 Direct Liquid Injection Systems
 - 2 Liquid Delivery Systems

In vacuo XPS and *in situ* Raman spectroscopy available on the system as well as CVD for carbon nanotubes (CNTs) and ion-beam sputter deposition.

ALD Materials and Application Areas

1. Metals

Copper

- Seed layers for metallization of nanoelectronic interconnect systems and through-silicon vias (TSVs) in 3D integration
- Functionalization of CNTs and CNT integration in metallization systems
- Non-magnetic layer in GMR stacks

Nickel

- Liner and seed layer in interconnect systems and for TSV metallisation
- Ferromagnetic film in magnetic/spinronic film systems
- Functionalization and metallization of CNTs

Cobalt

- Seed und liner in interconnect systems and for TSV metallization
- Ferromagnetic layer in magnetic/spinronic film systems

2. Metal Oxides

Copper Oxide

- Intermediate stage for ALD of copper
- Functionalization of CNTs, e.g. for sensors

Nickel Oxide

- Intermediate stage for ALD of nickel
- Functional film in magnetic/spinronic film systems
- Functionalization of CNTs, e.g. for sensors

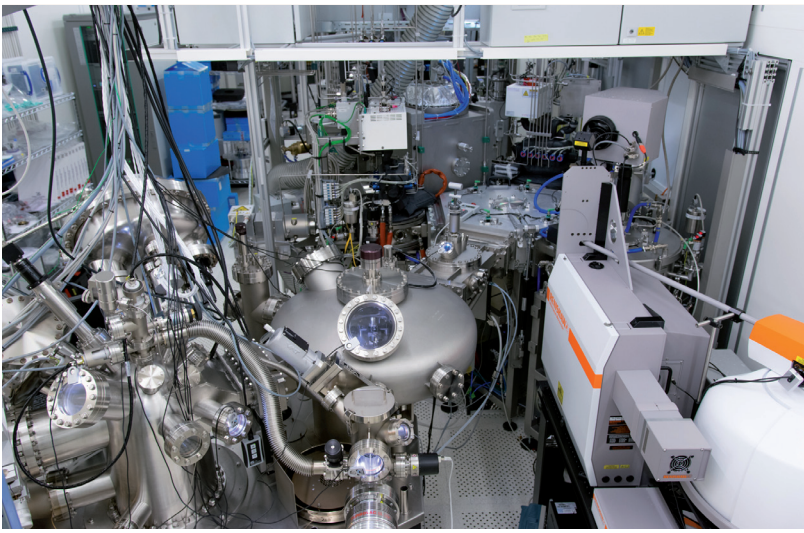
Aluminum Oxide

- Passivation layer, e.g. for MEMS, electronic devices, solar cells
- Dielectric with high permittivity, e.g. for storage/memory applications
- CNT functionalization

3. Metal Nitrides

Titanium Nitride

- Diffusion barriers against copper diffusion in nanoelectronic interconnect systems and TSVs for 3D integration
- Hard coatings/abrasion protection for MEMS



Working Areas

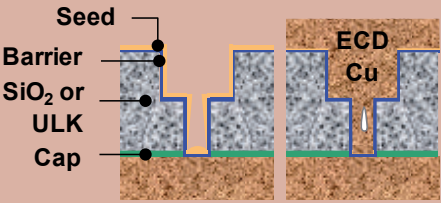
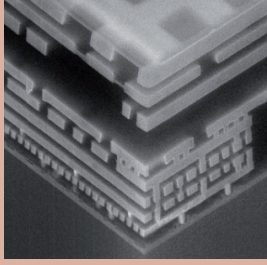
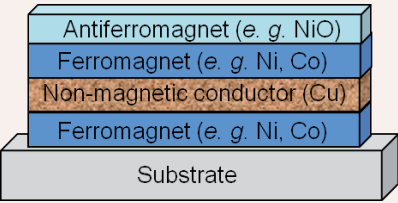
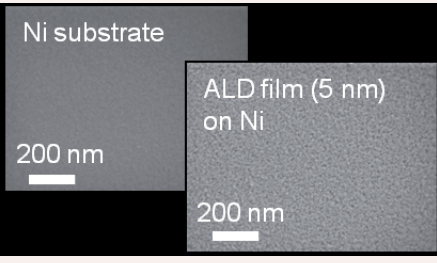
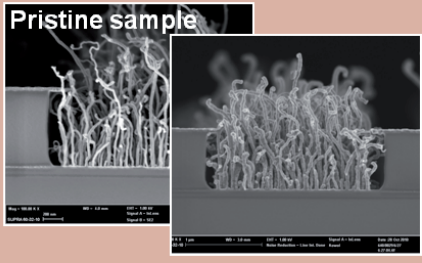
Interconnects	Spintronics	3D Nanostructures
  <p>Photo courtesy AMD Saxony / GLOBALFOUND- RIES Dresden</p> <ul style="list-style-type: none"> ALD Cu seed layers for ULSI interconnects Development of ALD processes for liner deposition (e. g. Co, Ni) 	 <p>Typical GMR spin valve layer stack</p> <ul style="list-style-type: none"> ALD utilization for spintronic devices, such as GMR sensor systems  <p>SEM top view images</p>	<ul style="list-style-type: none"> Functionalization of 3D nanostructures by ALD coating with conformal layers or nanoparticles, e. g.: <ul style="list-style-type: none"> CNTs Nanowires Porous materials  <p>SEM images of vertically aligned MWCNTs in via holes</p>

Figure:
Roth&Rau 200 mm multi-chamber tool for *in vacuo* processing. (left);
ALD modul with direct liquid injection systems (Vapbox 500, Kemstream). (right)

Photo acknowledgments: Fraunhofer ENAS
All information contained in this datasheet is preliminary and subject to change. Furthermore, the described systems, materials and processes are not commercial products.