MNF
MICRO NANO FACILITY

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MNF is the Micro-Nano characterization & fabrication Facility of Fondazione Bruno Kessler, Centre for Materials and Microsystems. Our activity is focussed on two main pillars:

- development and application of surface science analytical techniques and related methodologies for the characterization of materials at the micro and nano scale,
- development, production and packaging of innovative devices based on silicon compatible technology, with a focussed expertise on Radiation Sensors and MEMS-devices to be used in the fields of optical and particle detection, transduction, RF and optics.

The MNF is open to external customers belonging to both the research and the industrial worlds.

MICROFABRICATION AND TESTING AREAS

These Areas of MNF offer the entire development cycle of advanced miniaturized devices based on over 20 years of experience Microfabrication expertise is focused on radiation sensors and MEMS for silicon microdevices

Clean Rooms

Substrates
• Standard, running on all equipment: silicon and quartz wafers, 6”, 250 – 675 um thick, primary flat only • Other substrates have to be evaluated • Double side processing – to be verified according to the process flow

Equipment	Varian Exitron 220 Ion implanater
Process	accelerated ions impantation
Process main features	
• Energy range: up to 200 KeV • Current intensity: up to 900 uA • Ions As75, B11, 49, P31, N, Ar40 • 5% uniformity • 2D and 3D resistivity maps	
Process control	
• Resistivity control by 4 point probe – statistics and 2D/3D wafer maps	

Equipment	Alcatel AMS200
Process	Deep reactive ion etching
Process main features	
• Silicon deep etching • Bosch process • Edge protection fixture • Soft and hard mask • Etch rate, 1 for deep and one for surface etching	
Process control	
• SEM	

Equipment	OEM Tegal 903 ACS
Process	Plasma surface etcher
Process main features	
• Silicon oxide and silicon nitride dry, plasma etching • 95% uniformity	
Process control	
• Timely checked etch rate on HU450 200 nm Thermal Oxide on silicon	

Equipment	OEM Tegal 6510 – PM1
Process	Plasma surface etcher
Process main features	
• Polysilicon dry, plasma surface etching • 95% uniformity	
Process control	
Timely checked etch rate on 300/500 nm UD-Poly/Th-Ox Recipe 1PYEP_1	

Equipment	OEM Tegal 6510 – PM2
Process	Plasma surface etcher
Process main features	
• Metal dry, plasma surface etching • 95% uniformity	
Process control	
Timely checked etch rate on recipe 2_Al1200E 500/500 nm Al1%Si/TEOS	

Equipment	Eclipse MRC Mark II sputter
Process	Magnetron sputter
Process main features	

• 4 chambers: 1 etch and 3 sput – Al, AlSi1%, Ti/TiN
• Process vacuum down to 1e-9 Torr
• Sput heating up to 500 C
• Automatic multiple loop recipes – multilayer repetition without exiting the plenum
• Standard thicknesses
  o Pure Alunimum (0.1-4 um)
  o 1% Si Aluminum (0.1- 4 um)
  o Titanium (0.02-0.06um)
  o Titanium nitride (0.03-0.08 um)
• Customizable thicknesses
• Customizable N2, Ar fluxes and deposition bias and power	

Process control	
• Resistivity control by 4 point probe – statistics and 2D/3D wafer maps • Deposition rate	

Equipment	Stepper Nikon Mod. NSR-2205i11D
Process	Photolithography - exposure
Process main features	
• 6” reticle • Resolution : 0.35μm	
Process control	
• Automatic internal controls	

Equipment	Mask aligner Karl Suess Mod. MA150BSA
Process	Photolithography - exposure
Process main features	
• proximity cassette-to-cassette with back side alignment (2.5 μm resolution)	

Equipment	Mask aligner Karl Suess Mod. MA6
Process	Photolithography - exposure
Process main features	
• proximity and hard contact cassette-to-cassette (2.5 µm resolution) • Lift off: o Negative resist MaN1420: 2.1µm thickness – 4nm 1σ • Thick resist processing: o SU8 negative resist (from 5µm to 200µm thickness) o AZ4562 positive resist (thickness 6.7µm)	

Equipment	Track EVG150
Process	Photolithography – coating and developing
Process main features	
• Positive Resist HIPR6512: 1.2µm thickness - 3nm 1σ • Positive Resist HIPR6517HC: 2.1µm thickness - 6nm 1σ	
Process control	
• Weekly Resist Deposition thickness and uniformity on HIPR6512	

Equipment	Track SVG8600
Process	Photolithography – coating and developing
Process main features	
• Positive Resist HIPR6512: 1.2µm thickness - 3nm 1σ • Positive Resist HIPR6517HC: 2.1µm thickness - 6nm 1σ	
Process control	
• Weekly Resist Deposition thickness and uniformity on OIR 674-09	

Equipment	STS - MPS CVD
Process	Plasma enhanced thin film deposition
Process main features	
• Si Oxide 250 - 300 C • Si Nitride 250 - 300 C • Stress ctrl Si Nitride (- 800 to + 500 MPa) 250 - 300 C • Si Oxi-Nitride (SiON) 250 - 300 C • Si rich Oxide - • Amorphous Si 300 C • High frequency and low frequency generator setup • Mechanical stress control	
Process control	
• Timely checked deposition rate on reference high frequency SiO_2 and SiN recipes	

Equipment	Centrotherm E 1200 HT 260-4 (4) diffusion and LPCV furances
Process	LPCVD, diffusion, oxidation, doping

Process main features

- LPCVD – TEOS, SiN, PolySi:
  - Undoped TEOS (718 °C , +/- 3% - 20 nm to 2 μm)
  - P-doped TEOS (640 °C , +/- 3% - 20 nm to 2 μm)
  - BPSG (640 °C , +/- 3% - 20 nm to 2 μm)
  - Undoped Poly-Si (620 °C , +/- 4% - 20 nm to 1 μm)
  - in situ P-doped Poly (580 °C , +/- 4% - 20 nm to 1 μm)
  - Si Nitride (775 °C , +/- 3% - 20 nm to 0.3 μm

- Atmoshperic
  - Dry oxidation (upto 1150 °C, +/-4% uniformity)
  - Wet oxidation (upto 1150 °C, +/-4% uniformity)
  - Boron from BBr_3 (+/-4% uniformity)
  - Phosphorus from $POCl_3$ (+/-4% uniformity)
  - N_2 annealing (up to 1150 °C)
  - 7% H_2 alloying/sintering

Further capabilities

- Metalization - Ulvac EBX-16C with e-gun Ferrotec EV S-6 (min. thickness: 3 nm):
  - Gold
  - Chrome
  - Palladium
  - Aluminum
  - Titanium
  - Platinum
  - Silver

- Electrodeposition (Rena Wet bench)
  - Gold

- Anisotropic wet etching:
  - TMAH Bulk Si Wet

- Isotropic wet etching :
  - Silicon Oxide (no metal)
  - Silicon Oxide (metal)
  - Silicon Nitride
  - PolySilicon
  - Aluminum

- Resist stripping :
  - Photoresist Dry Matrix (single) 600 nm/min -

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- Photoresist Dry Tepla (batch) 40 nm/min
- Photoresist XXX (single) XXX nm/min
- Photoresist Wet Etch (piranha)

- Metrology capabilities – MEMS and Radiation detectors:
  - Interferometer
  - Mechanical profilometer
  - 4 point probe
  - Lifetime Sinton system
  - Wafer curvature
  - Elipsometer
  - Scanning Electron Microscope

- Wafer bonding AML:
  - Si fusion bonding
  - Anodic bonding
  - Au-Si eutectic bonding
  - Glas frit bonding
  - Adhesive bonding

Package/Integration Lab

Equipment	VS1520A Aurel
Process	Screen Printer/Stencil Printer
Process main features	Thick film deposition

Equipment	Bonder Tresky T3000 FC3
Process	Assembly station
Process main features	Pick and Place bonding die

Equipment	Kuliche Soffa K&S 4700 F&S/04701
Process	Dual Wedge/Ball Analog bonder
Process main features	Ball Bonder

Equipment	XYZ Tech EZ400 XPC000730
Process	shear and pull test XYZ
Process main features	Bond tester

Equipment	ATV SRO 700 - PCE SRO-700-100 Furnace
Process	Furnace
Process main features	Programmable IR vacuum reflow soldering/thermal processing/RTA system

Equipment	DISCO DAD 2H/6T
Process	Wafer dicing
Process main features	Up to 6 inches wafer dicing

Automatic Testing Lab

Equipment	EG2001 - Agilent
Process	Automatic cass-to-cass Probe station
Process main features	o Double side automatic testing o 4 channels I/V SMU (Source monitor Units) 100Volts, 100mA o 2 channels I/V SMU (Source Monitor Units) 200Volts, 1A o 4 channels VS (voltage source) o 2 channels VM (voltage monitor) for high precision measures o 1 channel CMU (capacitance monitor Unit) 10KHz-2MHz bridge o 13 x 48 Switching matrix for 48 pin max probecard connection o 150 mm wafer testing

Equipment	ACCRETECH UF200 - Agilent
Process	Automatic cass-to-cass Probe station
Process main features	o Double side automatic testing o 4 channels I/V SMU (Source Monitor Units) 100Volts, 100mA o 2 channels I/V SMU (Source Monitor Units) 200Volts, 1A o 4 channels VS (voltage source) o 2 channels VM (voltage monitor) for high precision measures o 1 channel CMU (capacitance monitor Unit) 10KHz-2MHz bridge o 8 x 48 Switching matrix for 48 pin max probecard connection o 100,125, 150, 200 mm wafer testing (automatic loading)

Manual Testing Lab

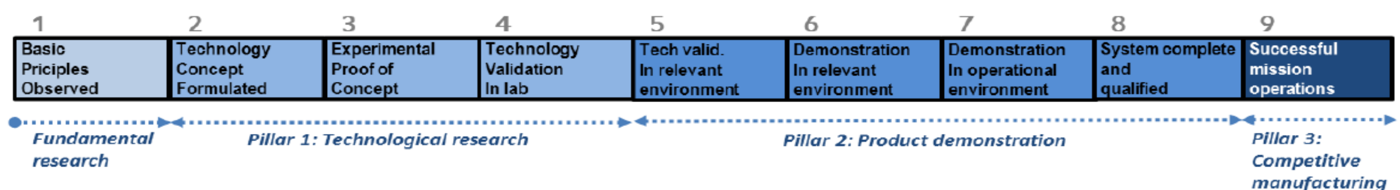
Equipment	Manual Probe station - Agilent
Process	Manual probe station
Process main features	○ 4 channels I/V SMU (Source Monitor Units) 100volts ,100mA ○ 2 channels VS (voltage source) ○ 2 channels VM (voltage monitor) for high precision measures ○ 1 channel CMU (capacitance monitor Unit) 10Hz-25MHz bridge ○ 1 channel LCR meter 5Hz-13MHz bridge ○ 1 channel High Voltage SMU , 1100Volts, 100mA ○ 8 micro-manipolator

Equipment	Electro-optical (LWIR) test facility
Process	Electro-optical characterization
Process main features	○ Low temperature Blackbody sources 20 - 90 C ○ 150 x 150 x 800 motorized precision XYZ stage ○ Keithley 2636 dual channel Picoammeter ○ Signal recovery 7265 Lock-in ○ NIR-LWIR monochromator Jobin-Yvon HR250 ○ LWIR calibrated detectors (pyro-electric) ○ Full E-O device characterization SW ○ Automatic power measurement set-up ○ Automatic spectral meas. set-up

MNF devices TRL

Available device technologies

ID	Product	TRL
Code	Short Description	1 - 9
SiPM	Silicon Photomultiplier	7
RF	RF MEMS	3
PHT	Space–qualified Phototransistors	8
PT	OEM Phototransistors	8
PD	OEM Photodiodes	8
H2	GasFet H_2 sensor	4
PV Cell	Photovoltaic Cell	7
µ-Strip	µ-Strip Large Area Detectors	7
MAS	Mass Flow Sensors	4
CMUT	Capacitive U/S Transducers	3
µ-Heat	µ-Heaters	4
Si3D	Silicon 3D Devices	4



MATERIAL CHARACTERIZATION AREA

This Area of MNF is focused on solving novel analytical issues and supporting material science and technology development by state-of-the-art analytical instrumentation and capabilities.

Mass Spectrometry

- Dynamic Secondary Ion Mass Spectrometer (CAMECA IMS WF/SC-Ultra)
  - Floating voltage column allowing impact energies down to 200 eV for ultimate depth resolution
  - Rotating Stage to reduce surface roughness formation during ion bombardment
  - Mass resolution M/dM up to 20000

- Time of Flight Secondary Ion Mass Spectrometer (IONTOF IV upgraded with a Bismuth cluster source
  - Chemical imaging with lateral resolution < 1 micron
  - Sputter guns (Cesium, Oxygen, Xenon)
  - Unlimited Mass range (typically 10000)
  - Temperature control on stage (~130K-570K)
  - Mass resolution M/dM ~ 8000

- Time of Flight Proton Transfer Reaction Mass spectrometer (KORE Technology)
  - Detection of volatile organic compounds (VOCs) with detection limits of a few pptV
  - Mass resolution M/dM ~ 1300

Microscopy

- Scanning Electron Microscope (JEOL JSM 7401F)
  - Field Emission Source
  - Spatial Resolution ~1nm
  - Accelerating voltage 0.7-30 kV

  equipped with:
  - Energy Dispersive Spectrometry System (Bruker QuantaX EDS, 30 mm2)
  - Electron Backscatter Diffraction Detector (Bruker QuantaX EBSD)

- Atomic Force Microscopes (NT-MDT Solver P47H and Solver P47)
  - contact AFM/ LFM/ ResonantMode (semicontact + noncontact AFM)/ Phase Imaging
  - Force Modulation (viscoelasticity)/ MFM/ EFM/ Adhesion Force Imaging
  - AFM lithography
  - Scanning Capacitance Microscopy, Kelvin Probe Force Microscopy (surface potential)
  - Vertical resolution < 0.5 Å
  - Different scanning heads for different scan size vs vertical resolution settings

Electron Spectroscopies

- X-Ray Photoelectron Spectrometer Scienta ESCA 200
  - Monochromatic AlKa
  - Sputter gun Argon up to 5 keV
  - Hemispherical Analyzer
  - Energy resolution δE< 0.3eV on the Ag Fermi edge with a pass energy of 75eV

X-Ray Analysis (Fluorescence and Diffraction)

- X-Ray Fluorescence and Diffraction Spectrometer (TNX Phoenix)
  - Combined instrument for X-Ray Fluorescence (also in Grazing Incidence) Diffraction Reflectivity
  - Curve graded multilayer monochromator for MoKa radiation
  - SDD detector 50 mm2 active area (fluorescence)
  - Scintillator detector on 2-theta arm (reflectivity, diffraction)
  - Position Sensitive Hybrid detector (diffraction)

Preparation and support instrumentation

- Sputter coater (Emitech K-575X)
- Mechanical Profilomenter (KLA-Tencor P-6 stylus profilometer)
- Rapid Thermal Annealer (Annealsys As-Micro)
- Optical microscopes
- Diamond saw
- Flat lap grinder

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CERTIFICATE No. **28257/12/S**

SI CERTIFICA CHE IL SISTEMA DI GESTIONE PER LA QUALITA' DI
IT IS HEREBY CERTIFIED THAT THE QUALITY MANAGEMENT SYSTEM OF

FONDAZIONE BRUNO KESSLER

VIA SANTA CROCE, 77 - 38122 TRENTO (TN) ITALIA

NELLE SEGUENTI UNITA' OPERATIVE / *IN THE FOLLOWING OPERATIONAL UNITS*

MTLAB

VIA SOMMARIVE, 18- 38123 POVO DI TRENTO (TN) ITALIA

E' CONFORME ALLA NORMA
IS IN COMPLIANCE WITH THE STANDARD

ISO 9001:2008

PER I SEGUENTI CAMPI DI ATTIVITA' / *FOR THE FOLLOWING FIELD(S) OF ACTIVITIES*

SVILUPPO E PRODUZIONE DI DISPOSITIVI E MICROSISTEMI DELL'UNITA' MTLAB DEL CENTRO MATERIALI MICROSISTEMI

DEVELOPMENT AND PRODUCTION OF DEVICES AND MICROSYSTEMS BY THE MTLAB UNIT WITHIN THE MATERIALS AND MICROSYSTEMS CENTER

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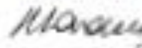

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