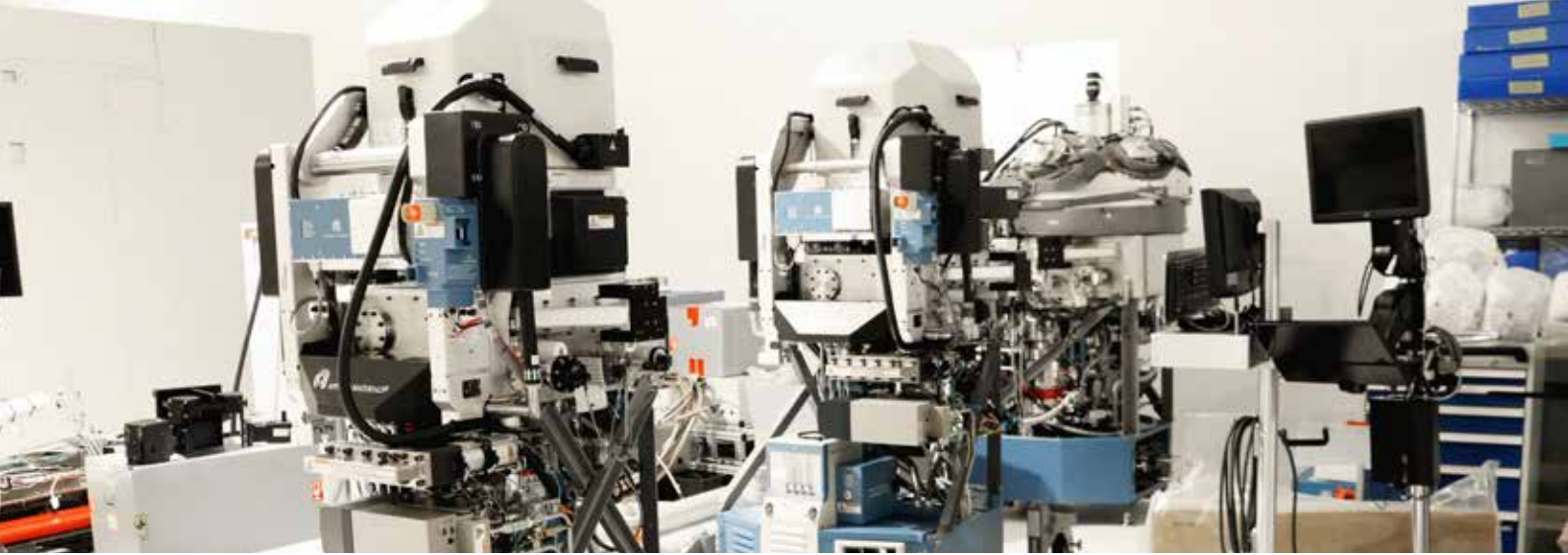


Process Catalogue & Equipment

The competencies of Fraunhofer IPMS' Center Nanoelectronic Technologies are focused on Next Generation Computing, devices for the Internet of Things and screening of processes and materials for 300 mm semiconductor manufacturing. More than 100 process and analytical tools for mainly 300 mm wafers are available. Developments and new processes can be quickly integrated into the production lines of partners thanks to our 4000 m² clean room as well as labs for analytics and electrical characterization compliant with state of the art industry standards.

Etch	TEL Tactras	AMAT Centura			AMAT Centura			
chamber	Vigus LK3 HC	Enabler	Axiom	AdvantEdge G3	Enabler	AdvantEdge G5	AdvantEdge G5	Mariana
details	ALE, RF pulsing	large variability in gases		large variability in gases	large variability in gases	high T 250°C, RF pulsing		narrow gap CCP
materials	dielectrics (low-k, ULK, oxides, nitrides)	dielectrics (low-k, oxides, nitrides), ash	ash	metals (TiN, Ti, Al, AlSiCu, W), high-k (HfO _x , ZrO ₂)	dielectrics (high AR oxides, nitrides), ash	high-k and gate stack (HfO _x , ZrO _x , AlO _x , TiN)	fine pitch Si etch	Si deep trench
contamination class	BEOL	BEOL			FEOL			

Clean Wet Etch	AMAT/Semitoool Raider				Screen SU-3200			Screen FC-3000		
chamber	water/acid	solvent	UV-cure	coating	BEOL Spray	FEOL Spray	Bevel	recirculated bath	PoU bath	Marangoni Dry
details	spray, center dispense, backside, (megasonic) bath		up to 1000°C	dispense	10–80 °C, front & back side	10–80 °C, front & back side	bevel and backside clean	recirculated up to 120°C, megasonic	point of use up to 65°C, megasonic	incl. HF last
materials	(d)HF, (hot) DI, custom water/acid chemicals	DI, custom solvents		custom chemicals	(u)dHF, SC1, CO2W, (h) DIW, 2x custom, solvent	(u)dHF, SC1, SC2, SPM, (h) DIW, DI-O ₃ , Solvent	dHF, (h) DIW, SC1, Solvent	SPM, SC1	SC1, (d)HF, HCL	IPA
contamination class	BEOL				BEOL / FEOL			FEOL		

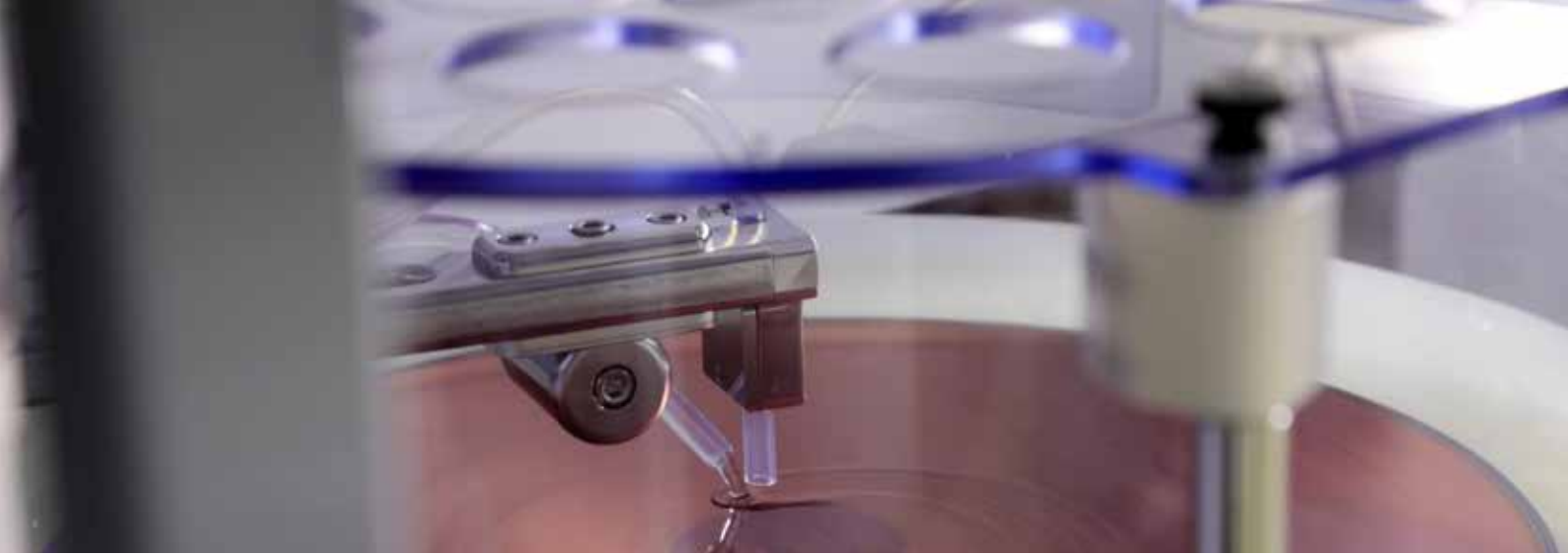


CVD	AMAT Producer			AMAT Endura	ASM XP8-Dragon		ASM A412
chamber	Black Diamond	BLOk / Precision APF	Nanocure 3 UV-Cure	Volta	TEOS	Silan	LPCVD reactor
details	PECVD, twin chamber 300°C–550°C	PECVD, twin chamber 300°C–550°C	twin chamber	MOCVD (CCTBA, CoCo), in-vacuo XPS, IR lamp anneal	PECVD, twin chamber	PECVD, twin chamber	50 wafer batch
materials	low-k, ULK, SiCOH, OMCTS, BDx	SiCN, SiN, SiO ₂ , carbon HM		Co	SiO ₂	SiN, SiO ₂	polySi, SiGe poly & Epi, a-Si, insitu B and P doping
contamination class	BEOL			BEOL	BEOL / FEOL		FEOL

ALD	ASM XP4		Jusung Eureka		ASM A412	AMAT Endura
chamber	EmerALD	Pulsar	ALD	ALD	LPCVD reactor	ALD
details	PEALD 50°C–350°C	thermal ALD 200°C–350°C	thermal ALD 200–400°C	thermal ALD 200–400°C	ALD/CVD	th. ALD 200–350°C
materials	SiO	HfO, ZrO, AlO	HfO, AlO, other	ZrO, AlO, other	TiN	Ta ₃ N ₅ (PDMAT)
contamination class	FEOL		FEOL		FEOL	BEOL

Anneal	TEL Formula	Mattson Helios XP	
specifics	Cu Anneal 100–400°C	RTP 250–1200°C	
gases, application	N ₂ , H ₂ , Ar, VAC	O ₂ , Ar, H ₂ , N ₂ O, N ₂	
contamination class	BEOL	FEOL	

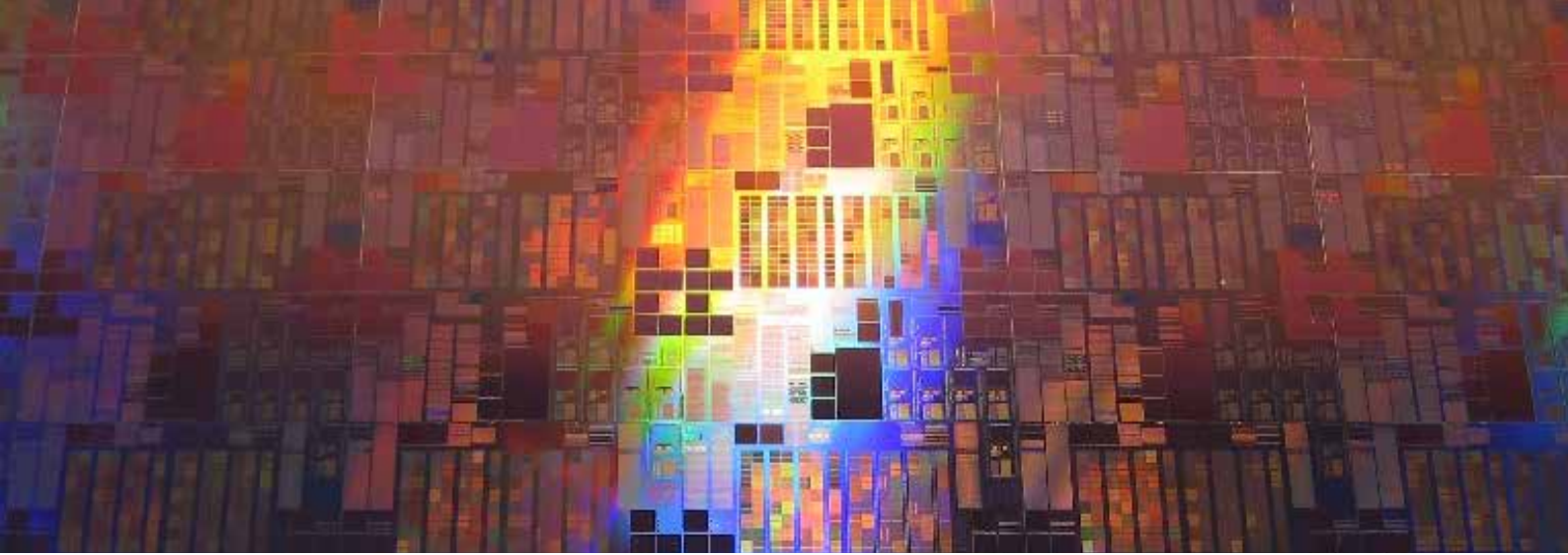
PVD	AMAT Endura		AMAT Endura			
chamber	ACCESS II	EnCoRe II	Clover	Clover MgO	Clover	Clover
details	PVD: ultra long range sputter, SIP; 3 EM, biased collimator; Cu-Backetch option with high rf bias up to 1kW, in-vacuo XPS	PVD: SIP; Ar-Backetch option with high rf bias >1kW, in-vacuo XPS	PVD: DC, pDC & Rf; up to 450°C; Cosputter	PVD: RF; superb uniformity, sub-nm layers (for all Clover)	PVD: DC up to 5 targets	PVD: DC up to 5 targets
materials	Cu	Ta, TaN, Ti, TiN	HfOx, Ti, TiN, Si	upon request	upon request	upon request
contamination class	BEOL		FEOL	MRAM		



CMP	AMAT Reflexion LK	
auxillary systems	flexible liquid supply system (4x platen feed; 2x cleaner feed), slurry analysis (Malvern Zetasizer; SITA DynTester+)	
process	Metalization/Damascene	Oxide/STI
endpoint systems	Eddy-Current, optical (fixed wavelength), motor torque	optical (white light spectrometer), motor torque
materials	Cu, Co, Ta/TaN, TEOS, ULK	SiO ₂ (TEOS/HARP/HDP), Si ₃ N ₄ , SiGe
contamina-tion class	BEOL / FEOL	

Litho	Vistec SB3050 (shaped beam)	TEL Track (ACT12)	Brewer Science
substrates	150/200/300 mm substrates	full automatic 300 mm wafer coating / developing	stand alone coater & developer, 100, 200 mm substrates
details, spe-cifications	CD dense line/vias: <40 nm; iso line/vias: <20 nm; overlay: <20 nm	ca. 80 nm nCAR, ca. 60 nm/ 120 nm/ 480 nm pCAR, 1 µm iLine resist	
contamina-tion class	BEOL / FEOL	BEOL / FEOL	BEOL / FEOL

ECD	AMAT / Semitool Raider ECD		Lam Sabre Extreme		
chambers & processes	Cu Damascene, Co Damascene	Post Clean, Bevel Etch, Anneal	Cu Damascene, Cu TSV	Cu RDL, Pillar, Bump Pre Wet	Post Clean, Bevel Etch, Anneal
contamina-tion class	BEOL		BEOL / BE (UC)		



METROLOGY		ANALYTICS		ELECTRICAL CHARACTERIZATION	
Tool name & supplier	Details	Tool name & supplier	Details	Equipment	Details
KLA SP2	Surface scan particle measurement	ToF-SIMS.5 from iontof	Cs and O gun	Wafer probing stations	
KLA SP3		AFM Cypher from Oxford instruments	Additional piezo response mode	TEL Automatic wafer probers 200/300 mm	lab and inline
KLA RS100	4-point probe resistance measurement	XPS Quantes from Phi	with Al and additional Cr (HAXPES), Sample heating and cooling, imaging mode	FormFactor/Süss Microtec Semiautomatic wafer probers	couponlevel upto 300 mm, -60°C ... 300°C, nitrogen purging possible
Nextin AEGIS	patterned defect inspection, bright and darkfield		XRR/XRD D8 Discover from Bruker	thickness, material properties, HighTemperature option	Imina MiBot system
AMAT Verity 4i	CD-SEM	SEM ApreoS from ThermoFisher, SEM S5000 from Hitachi	equipped with electron diffraction for transmission (TKD) and backscattering (EBSD) and EDX	Cryogenic Probestation Quantum Design Opticool	T <2K, H-Field <7T
Veeco 3D-AFM	In line AFM with trench capability and charge compensation		FIB/SEM Strata 400 from FEI	Dual beam, GIS: C and Pt, EDX	Cryogenic Probestation Bluefors Dilution refrigerator
KLA Spectra FX100	film thickness and uniformity, wafer bow	FIB Helios 5 UC from ThermoFisher	GIS: W and C, de-layering, low k etch, EDX up to Li, Raith Multibeam	Cryogenic Probestation Kiutra L-Type Rapid	T <100mK, H-Field <5T
XPS from Nova and Thermo Fisher	With Al-Anode → Sputter depth and angle resolved profiling	TEM Tecnai F20 from FEI	200 kV, energy filter (EFTEM, EELS) and EDX	Test equipment	
AMAT CD-SEM	CD-SEM measurements	InVia µRaman Microscope from Renishaw	composition analysis, stress measurement	Keysight Semiconductor Parameter Analyzers	CV/IV device char., NVM char., device reliability
AMAT G3i Review SEM	EDX and FIB capability and tilted stage	Axio Imager A2 Vario from Zeiss	up to full 300 mm wafer mapping, BF, DF, C-DIC	Keysight Vector Network Analyzer	RF IV, loadpull, parameter measurement up to 170 GHz
KLA HRP340	Several needles and 3D option	TXRF S2 from Picofox	elemental analysis	ProPlus FlickerNoise characterization and AdMOS FlickerNoise characterization system	flicker noise, 1/f noise, RTN characteri
XRR/XRD from Bede (Bruker)	Thickness measurement, Material properties (roughness, density, cryst. structure, texture)			NI PXle Systems optimized for Mixed-Signal Test	NVM array characterization
KLA Optical Microscope	optical inspection			Aixacct TF3000 FE-Polarization Analyzers	ferroelectric polarization and switching studies
				High temperature storage cabinets	nitrogen purged
				Infratec Lock-In Thermography camera	failure localization and thermal characterization
				Hprobe MRAM test system	MTJ device char., RH measurements
				KLA/Capres CIPT	char. of magnetoresistance / tunneling resistance on MTJ stacks