

NCCI ALD Capabilities

<u>NCCI Site</u>	<u>ALD tool</u>	<u>ALD film</u>	<u>Precursor 1</u>	<u>Precursor 2</u>	<u>Film status</u>		
Cornell	Oxford FlexAl	Al <sub>2</sub> O <sub>3</sub> Plasma	TMA	O <sub>2</sub>	established		
		Al <sub>2</sub> O <sub>3</sub> Thermal	TMA	H <sub>2</sub> O	established		
		AlN Plasma	TMA	N <sub>2</sub> +H <sub>2</sub>	established		
		HfO <sub>2</sub> Plasma	TEMAH	O <sub>2</sub>	established		
		HfO <sub>2</sub> Thermal	TEMAH	H <sub>2</sub> O	established		
		HfN Plasma	TEMAH	N <sub>2</sub> +H <sub>2</sub>	established		
		SiO <sub>2</sub> Plasma	3DMAS	O <sub>2</sub> + Ar	established		
		Si <sub>3</sub> N <sub>4</sub> Plasma	3DMAS	N <sub>2</sub> + Ar	established		
		TaN thermal	PDMAT	NH <sub>3</sub>	established		
		TaN Plasma	PDMAT	H <sub>2</sub>	established		
		Ta <sub>2</sub> O <sub>5</sub> thermal	PDMAT	H <sub>2</sub> O	established		
		Ta <sub>2</sub> O <sub>5</sub> plasma	PDMAT	O <sub>2</sub>	established		
		HfSiO <sub>2</sub> plasma	TEMAH + 3DMAS	O <sub>2</sub>	established		
		HfSiON plasma	TEMAH + 3DMAS	O <sub>2</sub> +N <sub>2</sub>	established		
		HfAlO <sub>x</sub> plasma	TEMAH + TMA	O <sub>2</sub>	established		
		Arradiance GEMStar6		Al <sub>2</sub> O <sub>3</sub> Thermal	TMA	H <sub>2</sub> O	established
				TiO <sub>2</sub> thermal	TDMATi	H <sub>2</sub> O	established
				Pt thermal	Pt(MeCp)Me <sub>3</sub>	O <sub>2</sub>	established
				SiO <sub>2</sub> thermal	t-butoxysilanol	TMA	established
				Pt thermal	Pt(MeCp)Me <sub>3</sub>	ozone	pending
		TiN thermal	TDMATi	NH <sub>3</sub>	pending		
Stanford	Cambridge Nanotech Savannah Fiji 1, 2, 3 Savannah MVD	Al <sub>2</sub> O <sub>3</sub> thermal	TMA	H <sub>2</sub> O	established		
		Al <sub>2</sub> O <sub>3</sub> plasma	TMA	O <sub>2</sub>	established		
		HfO <sub>2</sub> thermal	TDMA-Hf	H <sub>2</sub> O	established		
		HfO <sub>2</sub> plasma	TDMA-Hf	O <sub>2</sub>	established		
		TiO <sub>2</sub> thermal	TDMA-Ti	H <sub>2</sub> O	established		
		TiO <sub>2</sub> plasma	TDMA-Ti	O <sub>2</sub>	established		
		ZrO <sub>2</sub> thermal	TDMA-Zr	H <sub>2</sub> O	established		
		ZrO <sub>2</sub> plasma	TDMA-Zr	O <sub>2</sub>	established		
		SiO <sub>2</sub> plasma	3DMAS	O <sub>2</sub>	established		
		Pt thermal	Me(CpMe)Pt	O <sub>2</sub>	established		
		Pt plasma	Me(CpMe)Pt	O <sub>2</sub> + H <sub>2</sub>	established		
		TiN thermal	TDMA-Ti	NH <sub>3</sub>	established		
		TiN plasma	TDMA-Ti	N <sub>2</sub>	established		
		TiN plasma	TDMA-Ti	NH <sub>3</sub>	established		
		ZnO thermal	DEZ	H <sub>2</sub> O	established		
		Ta <sub>2</sub> O <sub>5</sub> thermal	TDEMATB-Ta	H <sub>2</sub> O	established		
		Ta <sub>2</sub> O <sub>5</sub> plasma	TDEMATB-Ta	O <sub>2</sub>	established		
		HfN thermal	TDMA-Hf	NH <sub>3</sub>	demonstrated		
		HfN plasma	TDMA-Hf	N <sub>2</sub>	demonstrated		
		WO thermal	BTDBMA-W	H <sub>2</sub> O	demonstrated		
		WO plasma	BTDBMA-W	O <sub>2</sub>	demonstrated		
		WN thermal	BTDBMA-W	NH <sub>3</sub>	demonstrated		
		WN plasma	BTDBMA-W	N <sub>2</sub>	demonstrated		
		Ru thermal	(CpEt)Ru	O <sub>2</sub>	demonstrated		

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Stanford	Cambridge Nanotech continued	SnO thermal	TDMA-Sn	H2O2	demonstrated
		InO thermal	CpIn	H2O	demonstrated
		Y2O3 thermal	Me(3MeCp)Y	H2O	demonstrated
			Me(2MeEtCp)Y	H2O	demonstrated
		NiO thermal	nickelocene	H2O	demonstrated
		FeO thermal	ferrocene	H2O	demonstrated
		AlN plasma	TMA	N2	demonstrated
		SrO thermal	MeCpSr	H2O	demonstrated
		SiO2 thermal	tert-butoxy		
			silanol	TMA	discontinued?
Harvard	Cambridge Nanotech Savannah	Al2O3 thermal	TMA	H2O	established
		HfO2 thermal	TDMA-Hf	H2O	established
		TiO2 thermal	TDMA-Ti	H2O	established
		TiO2 thermal	Ti(3) isopropoxide	H2O	established
		Pt thermal	MeCpMe3Pt	O2	established
		SiO2 thermal	TBS	H2O	not pure ALD
		ZnO thermal	DEZ	H2O	developing
		AlZnO(AZO)	DEZ, TMA	H2O	developing
Minnesota	Cambridge Nanotech Savannah	Al2O3 thermal	TMA	H2O	established
		HfO2 thermal	TDMA-Hf	H2O	established
		SiO2 thermal	TBS	TMA	established
		TiO2 thermal	TTIP	H2O	established
		ZnO thermal	DEZ	H2O	established
Arizona St.	Cambridge Nanotech Savannah	Al2O3 thermal	TMA	H2O	established
		ZnO thermal	DEZ	H2O	established
		HfO2 thermal	TDMA-Hf	H2O	established
U. Penn	Cambridge Nanotech Savannah-S200	Al2O3 thermal	TMA	H2O	established
		HfO2 thermal	TDMA-Hf	H2O	established
		TiO2 thermal	TDMA-Ti	H2O	established
		ZrO2 thermal	TDMA-Zr	H2O	established
		SiO2 thermal	3DMAS	O3	established
Georgia Tech	Cambridge Nanotech Fiji F202	Al2O3 thermal	TMA	H2O	established
		Al2O3 plasma	TMA	O2	established
		HfO2 thermal	TDMA-Hf	H2O	established
		HfO2 plasma	TDMA-Hf	O2	established
		ZrO2 thermal	TDMA-Zr	H2O	established
		ZrO2 plasma	TDMA-Zr	O2	established
		ZnO thermal	DEZ	H2O	established
		ZnO plasma	DEZ	O2	established
		TiO2 thermal	TDMAT	H2O	established

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Georgia Tech	Cambridge Nanotech continued	TiO <sub>2</sub> plasma	TDMAT	O <sub>2</sub>	established
		Pt thermal	MeCpMe <sub>3</sub> Pt	O <sub>2</sub>	established
		Pt plasma	MeCpMe <sub>3</sub> Pt	O <sub>2</sub>	established
		TiN plasma	TDMAT	N <sub>2</sub>	established
		AlN plasma	TMA	N <sub>2</sub>	established
		HfN plasma	TDMA-Hf	N <sub>2</sub>	established
		ZrN plasma	TDMA-Zr	N <sub>2</sub>	established
Texas	Cambridge Nanotech Savannah 1 Savannah 2 Fiji	Al <sub>2</sub> O <sub>3</sub> thermal	TMA	H <sub>2</sub> O	established
		Al <sub>2</sub> O <sub>3</sub> plasma	TMA	O <sub>2</sub>	established
		HfO <sub>2</sub> thermal	TDMA-Hf	H <sub>2</sub> O	established
		HfO <sub>2</sub> plasma	TDMA-Hf	O <sub>2</sub>	established
		TiO <sub>2</sub> thermal	TDMAT	H <sub>2</sub> O	established
		TiO <sub>2</sub> plasma	TDMAT	O <sub>2</sub>	established
		ZrAlO	TDMA-Zr, TMA	H <sub>2</sub> O	established
		AlN thermal	TDMA-Al	NH <sub>3</sub>	established
Washington	Oxford OpAl	Al <sub>2</sub> O <sub>3</sub> thermal	TMA	H <sub>2</sub> O	established
		Al <sub>2</sub> O <sub>3</sub> plasma	TMA	O <sub>2</sub>	established
Arizona St.	Cambridge Savannah S100	Al <sub>2</sub> O <sub>3</sub> thermal	TMA	H <sub>2</sub> O	established
		ZnO thermal	DEZ	H <sub>2</sub> O	established
		HfO <sub>2</sub> thermal	TDMA-Hf	H <sub>2</sub> O	established
U. Chicago	Ultratech Fiji G2	SiO <sub>2</sub> plasma	3DMAS	O <sub>2</sub>	established
		HfO <sub>2</sub> plasma	TDMA-Hf	O <sub>2</sub>	established
		HfO <sub>2</sub> thermal	TDMA-Hf	H <sub>2</sub> O	established
		TiO <sub>2</sub> plasma	TDMAT	O <sub>2</sub>	established
		TiO <sub>2</sub> thermal	TDMAT	H <sub>2</sub> O	established
		TiN	TDMAT	N <sub>2</sub>	established
		Al <sub>2</sub> O <sub>3</sub> thermal	TMA	H <sub>2</sub> O	established
		Al <sub>2</sub> O <sub>3</sub> plasma	TMA	O <sub>2</sub>	established
		AlN plasma	TMA	N <sub>2</sub>	established
		NbN plasma	TBDEN	N <sub>2</sub>	developing
		NbTiN plasma	TBDEN+TDMAT	N <sub>2</sub>	developing
		W plasma	BTSMW	H <sub>2</sub>	developing
		WO plasma	BTSMW	O <sub>2</sub>	developing
		WN plasma	BTSMW	N <sub>2</sub>	developing

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U. Chicago	Ultratech Savannah	Al <sub>2</sub> O <sub>3</sub> thermal	TMA	H <sub>2</sub> O	established
		Al <sub>2</sub> O <sub>3</sub> thermal	TMA	O <sub>3</sub>	established
		HfO <sub>2</sub> thermal	TDMA-Hf	H <sub>2</sub> O	established
		TiO <sub>2</sub> thermal	TDMAT	H <sub>2</sub> O	established
		ZrO <sub>2</sub> thermal	TDMA-Zr	H <sub>2</sub> O	established
		Pt thermal	MeCpMe <sub>3</sub> Pt	O <sub>3</sub>	established
		Al <sub>2</sub> O <sub>3</sub> SIS thermal	TMA	H <sub>2</sub> O	established
		TiO <sub>2</sub> SIS thermal	TDMAT	H <sub>2</sub> O	established
U. Kentucky	Cambridge Savannah	Al <sub>2</sub> O <sub>3</sub> thermal	TMA	H <sub>2</sub> O	established
		SiO <sub>2</sub>	3DMAS	O <sub>3</sub>	established
UC San Diego	Beneq TFS2000	Al <sub>2</sub> O <sub>3</sub> -thermal	TMA	H <sub>2</sub> O	established
		Al <sub>2</sub> O <sub>3</sub> -plasma	TMA	O <sub>2</sub>	established
		AlN plasma	TMA	NH <sub>3</sub>	established
		SiO <sub>2</sub> thermal	SAM.24	O <sub>3</sub>	established
		SiO <sub>2</sub> plasma	SAM.24	O <sub>2</sub>	established
		TiO <sub>2</sub> thermal	TiCl <sub>4</sub>	H <sub>2</sub> O	established
		TiO <sub>2</sub> thermal	TTIP	H <sub>2</sub> O	established
		TiO <sub>2</sub> plasma	TiCl <sub>4</sub>	O <sub>2</sub>	established
		TiN thermal	TiCl <sub>4</sub>	NH <sub>3</sub>	established
		HfO <sub>2</sub> thermal	TDMAH	H <sub>2</sub> O	established
		HfO <sub>2</sub> thermal	HfCl <sub>4</sub>	H <sub>2</sub> O	established
		ZnO thermal	DEZ	H <sub>2</sub> O	established
N.Carolina Chapel Hill	Ultratech Savannah S200	Al <sub>2</sub> O <sub>3</sub>	TMA	H <sub>2</sub> O	established
		CuO	Cu(dmap) <sub>2</sub>	H <sub>2</sub> O	demonstrated
		Ga <sub>2</sub> O <sub>3</sub>	TDMA-Ga	H <sub>2</sub> O	established
		HfO <sub>2</sub>	TDMA-Hf	H <sub>2</sub> O	established
		NiO	Bis(N,N'-di-t-butyl)H <sub>2</sub> O	H <sub>2</sub> O	established
		SnO <sub>2</sub>	TDMA-Sn	H <sub>2</sub> O, O <sub>3</sub>	established
		TiO <sub>2</sub>	TDMA-Ti	H <sub>2</sub> O	established
		ZnO	DEZ	H <sub>2</sub> O	established
		ZrO <sub>2</sub>	TDMA-Zr	H <sub>2</sub> O	established
		Duke-SMIF	Kurt Lesker 150LX	Al <sub>2</sub> O <sub>3</sub> - thermal	TMA
Al <sub>2</sub> O <sub>3</sub> - plasma	TMA			O <sub>2</sub>	established
HfO <sub>2</sub> - thermal	TDMAH			H <sub>2</sub> O	established
HfO <sub>2</sub> - plasma	TDMAH			O <sub>2</sub>	established
ZrO <sub>2</sub> - thermal	TDMAZ			H <sub>2</sub> O	established
ZrO <sub>2</sub> - plasma	TDMAZ			O <sub>2</sub>	established
TiN - plasma	TDMAT			N <sub>2</sub>	established
HfZrO <sub>2</sub> thermal	TDMAH, TDHAZ			H <sub>2</sub> O	established
HfZrO <sub>2</sub> plasma	TDMAH, TDHAZ			O <sub>2</sub>	established
Ga <sub>2</sub> O <sub>3</sub> plasma	TEG			O <sub>2</sub>	established

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NCSU-NNF	Ultratech Fiji	Al <sub>2</sub> O <sub>3</sub> - thermal	TMA	H <sub>2</sub> O	established
		Al <sub>2</sub> O <sub>3</sub> - plasma	TMA	O <sub>2</sub>	established
		HfO <sub>2</sub> - thermal	TDMAHf	H <sub>2</sub> O	in development
		HfO <sub>2</sub> - plasma	TDMAHf	O <sub>2</sub>	in development
		SiO <sub>2</sub> - plasma	Tris(dimethylamino)silane	O <sub>2</sub>	established
Northwestern	Arradiance XT-P 200mm	Al <sub>2</sub> O <sub>3</sub> thermal	TMA	H <sub>2</sub> O	established
		TiO <sub>2</sub> thermal	TDMAT	H <sub>2</sub> O	established
		HfO <sub>2</sub> thermal	TDMAH	H <sub>2</sub> O	established
		Pt	Pt(AcAc)		pending
		ZrO <sub>2</sub>	TDMAZ		pending
Louisville	Beneq	Al <sub>2</sub> O <sub>3</sub> thermal	TMA	H <sub>2</sub> O	established
		TiO <sub>2</sub> thermal	TiCl <sub>4</sub>	H <sub>2</sub> O	established
		ZnO thermal	DEZ	H <sub>2</sub> O	established