



SEMI AUX035-0525 REPORT ON CLOSING METROLOGIES GAPS FOR CMP PADS

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Report on Closing Metrologies Gaps for CMP Pads

Chemical Mechanical Planarization Consumables
(CMP-C) Task Force

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Goal

- Identify existing metrology gaps in measuring and reporting properties of CMP pads and its components
- Guide pad suppliers, suppliers of pad components and raw materials, vendors of the analytical tools and IDMs/ODMs to close existing metrology gaps

Acronyms

• AFM-	Atomic Force Microscopy	• Mw	Molecular Weight
• CoF	Coefficient of Friction	• NCO	Nitrogen/Carbon/Oxygen isocyanate group
• DMA	Dynamic Mechanical Analysis	• NMR	Nuclear Magnetic Resonance
• FTIR	Fourier Transformed Infrared Spectroscopy	• OES	Optical Emission Spectroscopy
• GPC-	Gel Permeation Chromatography	• OM	Optical Microscopy
• HPLC	High Performance Liquid Chromatography	• PSR	Pad Surface Roughness
• ICP	Inductive Coupled Plasma	• SLS	Static Light Scattering
• IR	Infrared	• SR	Shear Rate
• MALDI	Matrix Assisted Laser Desorption/Ionization	• WLI	White Light Interferometry
		• WSR	Window Surface Roughness

Metrologies for CMP Pads

Pad Component	KPI	Property Measured	Existing Metrology	CMP Process In Line/ Off Line	Gap/ No Gap	Comment
Pad	Hardness	Hardness, static	Shore hardness	Off Line	GAP	Inaccurate
Pad	Compressibility	Thickness change	Compression tool	Off Line	GAP	Inaccurate
Pad	Thickness	Thickness	Caliper	Off Line	NO GAP	Metrology is not a limiting factor
Pad	Pore count	diameter	SEM or microscope	Off Line	GAP	Total pore volume is not routinely reported. Pore size and count, measured over the limited pad areas, are not representative of the whole pad. 2D cross-sectional representation of a 3D structure leads to statistical assumptions.
Pad	Modulus	Modulus, dynamic	DMA	Off Line	NO GAP	Measured as an RnD parameter. Not always reported at several temperatures, or at all.
Pad	Groove geometry	Width, depth; pattern	Optical or caliber	Off Line	NO GAP	Metrology is not a limiting factor
Pad	PSR	Surface Roughness	WLI, Confocal, AFM	Off Line	NO GAP	Metrology is not a limiting factor

Metrologies for CMP Pads

Pad Component	KPI	Property Measured	Existing Metrology	CMP Process In Line/ Off Line	Gap/ No Gap	Comment
Pad	Tensile strength	Force, Area	Instron-type	Off Line	NO GAP	Metrology is not a limiting factor
Pad	Composition	Correlation coef.	FTIR, RAMAN, Near IR	Off Line	NO GAP	Metrology is not a limiting factor
Pad	Density	Weight, Dimensions	Balances, Caliper	Off Line	NO GAP	Metrology is not a limiting factor
Pad	Uniformly dispersed metal contamination	Metal content	Digestion+ICP or NMR	Off Line	NO GAP	Metrology is not a limiting factor
Pad	Isolated metal contamination	Metal content	Digestion+ICP or NMR	Off Line	GAP	Sample prep is a limiting factor
Pad	CoF	Force in X-Z directions	Force gauges on the polisher	In Line	NO GAP	Metrology is not a limiting factor
Pad	Heat in polish	Temperature	IR Sensors	In Line	NO GAP	Metrology is not a limiting factor
Pad	Torque	Motor current	Built in tool	In Line	NO GAP	Metrology is not a limiting factor
Pad	Pad wear	Thickness	Mechanical, Optical	In Line & Off line	NO GAP	Metrology is not a limiting factor

Metrologies for CMP Pads

Pad Component	KPI	Property Measured	Existing Metrology	CMP Process In Line/ Off Line	Gap/ No Gap	Comment
Prepolymer	Molecular Weight	Mw distributions	GPC, HPLC, MALDI	NA	NO GAP	Metrology is not a limiting factor
Prepolymer +curatives	Hardness	Dynamic modulus	DMA	NA	NO GAP	Batch-to-batch variability for all raw materials. Metrology is not a limiting factor
Prepolymer +curatives	Degree of X-linking	NCO Dynamic modulus	Titration DMA	NA	NO GAP	Metrology is not a limiting factor
Prepolymer +curatives	Viscosity at a single SR	Static Viscosity	Viscometer	NA	NO GAP	Metrology is not a limiting factor
Prepolymer +curatives	Viscosity at different SRs	Dynamic Rheometry	Rheometer	NA	NO GAP	Metrology is not a limiting factor
Prepolymer +curatives	Density	Density	Densitometry	NA	NO GAP	Metrology is not a limiting factor
Prepolymer +curatives	Contamination	Trace metals	ICP	NA	NO GAP	Metrology is not a limiting factor
Softener+ prepolymer + curative	Hardness	Dynamic modulus	DMA	NA	NO GAP	Metrology is not a limiting factor
Softener+ prepolymer + curative	Viscosity at a single SR	Static Viscosity	Viscometer	NA	NO GAP	Metrology is not a limiting factor

Metrologies for CMP Pads

Pad component	KPI	Property measured	Existing Metrology	Process In Line/ Off Line	Gap/ No Gap	Comment
Softener+ prepolymer + curative	Viscosity at different SRs	Dynamic Rheometry	Rheometer	NA	NO GAP	Metrology is not a limiting factor
Softener+ prepolymer + curative	Density	Density	Densitometry	NA	NO GAP	Metrology is not a limiting factor
Softener+ prepolymer + curative	Contamination	Trace metals	ICP	NA	NO GAP	Metrology is not a limiting factor
Porogen	Shell Size	Size distribution	SLS; SEM	NA	NO GAP	Metrology is not a limiting factor
Porogen	Shell wall thickness	Shell thickness	SEM	NA	GAP	Variations in bubble porogen expansion
Porogen	Density	Balloon density	Pycnometer	NA	NO GAP	Metrology is not a limiting factor
Porogen	Contamination	Trace metal	ICP	NA	NO GAP	Metrology is not a limiting factor
PSA , pad-platen	AS	Max Force during delamination	180 or 90 degree peel/Instron type	NA	GAP	ASTM Standard exists. Lack of SEMI industry standard tests with specified delamination speed, ambient temperature. Results dependency on adhesive/tape thickness.

Metrologies for CMP Pads

Pad component	KPI	Property measured	Existing Metrology	CMP Process In Line/ Off Line	Gap/ No Gap	Comment
PSA, pad-platen	AS	Force at delamination	Shear/Instron type	NA	GAP	ASTM Standard exists. Lack of SEMI industry standard tests with specified shear speed, ambient temperature.
Adhesive pad-subpad	AS	Max Force during delamination	180 or 90 degree peel/Instron type	NA	GAP	ASTM Standard exists. Lack of SEMI industry standard tests with specified delamination speed, ambient temperature. Results dependency on adhesive/tape thickness
Adhesive pad-subpad	AS	Force at delamination	Shear/Instron type	NA	GAP	ASTM Standard exists Lack of SEMI industry standard tests with specified shear speed, ambient temperature.
Adhesive pad-subpad	Adhesive thickness	Thickness	Cross-sectional OM	NA	NO GAP	Metrology is not a limiting factor
Window	Thickness	Thickness	Calipers	Off Line	NO GAP	Metrology is not a limiting factor
Window	Adhesion	AS	Proprietary metrology	Off Line	NO GAP	Not always measured, no unified metrology
Window	Light transmission	Transmission at certain different wavelengths	Transmission spectroscopy	Off Line	NO GAP	Metrology is not a limiting factor
Window	Hardness	Compression	Shore D hardness	Off Line	GAP	Accuracy for thin polymer windows

Metrologies for CMP Pads

Subpad	KPI	Property Measured	Existing Metrology	CMP Process In Line/ Off Line	Gap/ No Gap	Comment
Window	Roughness	WSR parameters, such as Ra, Rq, Rt	Optical & mechanical profilometer	Off Line	NO GAP	Metrology is not a limiting factor
Window	Window leaks	Liquid leaks thru window/pad interface	Custom IP metrology	Off Line	GAP	Not always measured, no unified metrology
Window	Signal stability	End point stability	Polisher	In Line	NO GAP	Metrology is not a limiting factor
Window	Contamination	Trace metals	ICP	Off Line	NO GAP	Metrology is not a limiting factor
Subpad	Hardness	Hardness, static	Shore hardness	Off Line	GAP	Inaccurate
Subpad	Compressibility	Thickness change	Compression tool	Off Line	GAP	Inaccurate
Subpad	Thickness	Thickness	Caliper	Off Line	GAP	May be inaccurate
Subpad	Density	Weight, dimensions	Balances, Caliper	Off Line	NO GAP	Metrology is not a limiting factor
Subpad	Modulus	Modulus, dynamic	DMA	Off Line	NO GAP	Measured as an RnD parameter. Not always reported at several temperatures, or at all.

Metrologies for CMP Pads

Stackpad	KPI	Property measured	Existing Metrology	CMP Process In Line/ Off Line	Gap/ No Gap	Comment
Subpad	Metal contamination	Metal content	Digestion+ICP or NMR	Off Line	NO GAP	Metrology is not a limiting factor
Subpad	Groove geometry	Width, depth; pattern	Optical or caliber	Off Line	NO GAP	Metrology is not a limiting factor
Subpad	PSR	Surface Roughness	WLI, Confocal, AFM	Off Line	NO GAP	Metrology is not a limiting factor
Subpad	Tensile Strength	Force, Area	Instron-type	Off Line	NO GAP	Metrology is not a limiting factor
Subpad	Composition	Correlation coef.	FTIR, RAMAN, Near IR	Off Line	NO GAP	Metrology is not a limiting factor
Subpad	Groove geometry	Width, depth; pattern	Optical or caliber	Off Line	NO GAP	Metrology is not a limiting factor
Subpad	PSR	Surface Roughness	WLI, Confocal, AFM	Off Line	NO GAP	Metrology is not a limiting factor
Subpad	Tensile Strength	Force, Area	Instron-type	Off Line	NO GAP	Metrology is not a limiting factor
Subpad	Composition	Correlation coef.	FTIR, RAMAN, Near IR	Off Line	NO GAP	Metrology is not a limiting factor

Metrologies for CMP Pads

Stackpad	KPI	Property Measured	Existing Metrology	CMP Process In Line/ Off Line	Gap/ No Gap	Comment
Stackpad	Hardness	Hardness, static	Shore hardness	Off Line	GAP	Inaccurate
Stackpad	Compressibility	Thickness change	Compression tool	Off Line	GAP	Inaccurate
Stackpad	Thickness	Thickness	Caliper	Off Line	GAP	May be inaccurate
Stackpad	Modulus	Modulus, dynamic	DMA	Off Line	NO GAP	Measured as an RnD parameter. Not always reported at several temperatures, or at all.
Stackpad	CoF	Force in X-Z directions	Force gauges on the polisher	In Line	NO GAP	Metrology is not a limiting factor
Stackpad	Heat in polish	Temperature	IR sensors	In Line	NO GAP	Metrology is not a limiting factor
Stackpad	Torque	Motor current	Built in tool	In Line	NO GAP	Metrology is not a limiting factor
Stackpad	Pad wear	Thickness	Mechanical, optical	In Line & Off Line	NO GAP	Metrology is not a limiting factor