Standards and reference samples for nano- & micro-measurement systems

This tabulated synopsis contains currently available artefacts which may be used as standards and which are suitable for the calibration of stylus or optical instruments and SPMs. Standards are listed in an arbitrary order within the sections without any ranking or preference. This list does not imply recommendation or endorsement by Physikalisch-Technische Bundesanstalt, nor does it imply that the listed standards are necessarily the best and/or only available for the purpose. No claim is put forward to the completeness and correctness of the list of manufacturers and products. If you know of further standards that might be included or if you have discovered outdated resp. incorrect data, PTB welcomes your feedback and appreciates any help to improve this list. This list may give a first overview, but it cannot replace consultation with the manufacturer resp. distributor. Please note that PTB itself does not sell standards and does neither benefit from the sale of standards nor from including them in this list. For certified calibration, please contact PTB or any other National Metrology Institute (NMI).

Last update: 2007-02-08

A) z - Axis: Single Step
B) z-Axis: Periodic Steps
C) z-Axis: Step Grating
D) x-, y-Axis: 1-Dimensional
E) x-, y-Axis: 2-Dimensional
F) 3D-Standards
G) Flatness
H) Thickness
I) Roughness
J) Critical Dimension
K) Tip Radius, Angle, Parallelity
L) Contour, Profile
M) Diameter, Roundness
N) Probing Force

→all PDF Images

No. *Nr.*	**Manufacturer** Hersteller	**Model** ***Modell***	**Measurement range** ***Messbereich***	**Description** ***Beschreibung***	**Image**	**Lateral Measurement Range** ***lateraler Messbereich***	**Substrate** ***Substrat***		**Coating** ***Beschichtung***		**Remarks** ***Bemerkungen***
			/nm			/µm	Material *Material*	Dimension *Dimension* */nm*	Material *Material*	Thickness *Dicke* /nm	
	A) **z - Axis:** Single Step	***A)*** ***z - Achse:*** ***Einzelstufen***									
A01.	SiMetricS	Depth Setting Standards VS	50 nm, ..., 1000 µm	grooves with rectangular profile and grooves with 54° slope, 100 µm wide, 6 mm length	**I**	³ 50 x 50	Silicon	50 x 50			suitable for microscopes
A02.	Pelco	AFM Gold Calibration Kit	5, 15, 30	Colloidal Gold spheres dispersed on Mica	**I**		Mica	Æ 9,9	Colloidal Gold	5 ... 30	suitable also for tip test; mounted on; Æ15 mm AFM disc
A03.	SLOAN/DEKTAK now Veeco		20, 50, 100, 200, 500, 1000, 5000, 10000	single bar with rectangular profile, 100 µm wide, 750 µm length	**I**		Quartz	25 x 25 x 9	Cr	90	various test and diagnostic features aa)
A04.	VLSI	SHS – 80, -180, -440, -880, -1800, -4500, -9400, - QC	8, 18, 44, 88, 180, 450, 940	single bar with rectangular profile, 100 µm wide, 750 µm length	**I**		Quartz	25 x 25 x 3	Cr	90	various test and diagnostic features bb)

A05.	VLSI	SHS – 1.8, -8.0, -24.0, -50.0, - Q	1800, 8000, 24000, 50000	trench 1 mm wide, 2.5 mm length	**I**		Quartz	25 x 25 x 3	Cr	90	Coating optional, suitable for stylus instruments bb)
A06.	Halle		200, ..., 9000	trenches of different width for each depth	**I**		Quartz	40 x 20 x 10			suitable for stylus instruments
A07.	MTT		30, ..., 3000	3 trenches with rectangular profile, 100 µm wide, 6 mm length	**I**		Silicon	Æ 37, 3 dick	Cr		suitable for stylus instruments
A08.	PTB	Cu Depth Setting Standards	1, 5, 20, 50, 200, 450, 600, 900, 1000, 2000, 5000 µm	grooves with 55° slope, distance between grooves: 400 µm, flat bottom (width 300 µm)	**I**	³ 1200... 8100	Copper	45 x 23, thickness: 10/12	Nickel	20	Type 900: 1...900 µm, Type 5000: 5 ...5000 µm

Home

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			/nm			/µm	Material *Material*	Dimension *Dimension* */nm*	Material *Material*	Thickness *Dicke* /nm	
	B) **z-Axis:** **Periodic Steps**	***B)*** ***z-Achse:*** ***periodische Stufen***									
B01.	MikroMasch	TGZ, -01,-02,-03,-04, -11; TGF11	20, 100, 500, 1000, 1500	TGZ: rectangular profile, pitch 3 µm; TGZ11: pitch 10 µm	I	£ 3000 x 3000	Silicon	5 x 5 x 0,45			
B02.	MikroMasch	TGF11	1750	TGF: trapezoidal, pitch 10 µm	I	£ 3000 x 3000	Silicon	5 x 5 x 0,45			
B03.	NTT-AT	Si(111) Atomic Steps	0,13, 0,31 nm	10 steps per 1 µm or 10 µm	I	£ 6000 x 6000	Silicon	10 x 10			humidity is kept as low as possible, perhaps use of desiccator for storage

Home

No. *Nr.*	**Manufacturer** Hersteller	**Model** *Modell*	**Measurement range** *Messbereich*	**Description** *Beschreibung*	**Image**	**Lateral Measurement Range** *lateraler Messbereich*	**Substrate** *Substrat*		**Coating** *Beschichtung*		**Remarks** *Bemerkungen*
			/nm			/µm	Material *Material*	Dimension *Dimension* */nm*	Material *Material*	Thickness *Dicke* /nm	
	C) z-Axis: Step Grating	***C) z-Achse: Stufen***									
C01	MikroMasch	UMG01, 02	20, 31	chess board pattern, pitch 2 µm	**I**	£ 400 x 400	Si	5 x 5			
C02	VLSI	STS 2 –180P, -440P, -1000S, -1800S	18, 44, 100, 180	waffle-like; pitch:1,8/ 3/ 5 mm	**I**	£ 270 x 270	SI	12 x 8 x 0,675	Pt	40	3 areas per die, P: coated, S: non coated, cc), ee)
C03	VLSI	STS 3 –180, -440, -1000, -1800, P	18, 44, 100, 180	waffle-like; pitch: 3/10/20 mm	**I**	£ 270 x 270	Si	12 x 8 x 0,5	Pt	40	3 areas per die, cc) , dd)
C04	VLSI	STR 3 –180, -440, -1000, -1800, -P	18, 44, 100, 180	waffle-like; pitch: 3 mm	**I**	£ 1200 x 1200	Si	8 x 8	Pt	40	also used as pitch standard / reference, cc)
C05.	VLSI	STR 10 -180, -440, -1000, -1800	18, 44, 100, 180	waffle-like; pitch: 10 mm	**I**	£ 4 000 x 4 000	Si	8 x 8	Pt	40	"
C06.	EU-Standard	partly available from	8, 24, 80, 240, 800,	grating and waffle-like;	**I**	£ 200 x 200	Si	5 x 7	Pt/Ir	70	mounted on disc

		Nanosensors	2400	8 - 240: pitch 4µm, 8µm, 80µm; 800 & 2400: pitch 16 µm, 40 µm		£ (1000 x 1000)					Æ12 mm

Home

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			/nm			/µm	Material *Material*	Dimension *Dimension* */nm*	Material *Material*	Thickness *Dicke* /nm	
	D) x-, y-Axis: 1-Dimensional	***D) x-, y-Achse: 1-Dimensional***									
D01	SiMetricS	Lateral Standard LS	10...2500	line grating, depth: 517 µm	I	250 ...62500	Si	75 x 20			ISO 5436-1 Type C3
D02	ASM	750-HD	750	Ni replica of a CD surface structure; pits arranged in lines, pitch 750 nm; height 100 nm	I	£ 6350	Ni	Æ 6,35, 0,3 mm thick	-	-	"High durability"
D03	MikroMasch	TGG 01	3 000	„ridge“ line grating with < 10 nm edge radius; height: 1,8 mm	I	£ 3 000 x 3 000	Si	5 x 5 x 0,45			also used as tip characteriser
D04	Moxtek	MXS – 301, -701,-CE	300, 700	line grating; height: 100 nm	I		Si	3 x 4 x0,5	W	60 nm	holographic pattern

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			/nm			/µm	Material *Material*	Dimension *Dimension* */nm*	Material *Material*	Thickness *Dicke* /nm	
	E) x-, y-Axis: 2-Dimensional	***E) x-, y-Achse: 2-Dimensional***									
E01	Photomaske		20 mm	Cr on quartz substrate	**I**	120 mm x 120 mm	Quartz	175 x 175	no		Test of the positioning properties
E02	VLSI	STS 2 –180, -440, -1000, -1800	1 800 + 3 000 + 5 000	waffle-like; step heights: 18, 44, 100, 180 nm	**I**	£ 270 x 270	SI	12 x 8 x 0,675	Pt	40	"
E03	VLSI	STR 3 –180, -440, -1000, -1800	3 000	waffle-like; step heights: 18, 44, 100, 180 nm	**I**	£ 1200 x 1200	Si	8 x 8	Pt	40	also used as step height standard / reference
E04	VLSI	STR 3 –180, -440, -1000, -1800	10 000	waffle-like; step heights: 18, 44, 100, 180 nm	**I**	£ 4000 x 4 000	Si	8 x 8	Pt	40	"
E05	EU-Standard	partly available from Nanosensors	100, 300,	array of neg. pyramides; depth: 35nm, 100 nm	**I**	£ 200 x 200	Si	5 x 7	-	-	etch-pits; shape defined by crystalline properties
E06	EU-Standard	Partly available from	1 000, 3 000, 10 000	flat-topped pyramide-like	**I**	£ 2 000 x	Si	5 x 7	Pt	100	holographic

		Nanosensors / Ibsen		posts; height: 100 nm		2 000					pattern
E07	Nanosearch Membrane	NanoCal	10 ... 15	S-layer on Si or glass	I		Silicon or glass				self-assembled layer
E08	MikroMasch	TGX01	3 000	chess-board, „flared“ pillars with < 5 nm edge radius; height: 900 nm	I	£ 2 000 x 2 000	Si	5 x 5 x 0,45	-	-	standard also used for 2-dim. tip characterisation
E09	Moxtek	MXS – 302 CE	300	cylindrical posts; height: 100nm	I		Si	3 x 4 x 0,5	W	60	commercial calibration software
E10	Moxtek	MXS – 702 CE	700	diamond-shaped posts; height: 100 nm	I		Si	3 x 4 x 0,5	W	60	
E11	NanoSensors		200	array of neg. pyramides; depth: 70 nm	I	£ 500 x 500	Si	7 x 7	-	-	etch-pits; shape defined by crystalline properties
E12	Pelco	607 – AFM 607 – STM	463 (2160 lines/mm)	Waffle grating replica	I				Au plated		AFM: uncoated, mounted on disc 12 mm STM: coated, but unmounted
E13	SIS		1 500	waffle-like pattern; height: 100 nm	I	£ 100 x 100	Glass/Cr		-	-	4 identical areas; Hex numbers in centre
E14	Supracon	Nanoscale	Pitch:	x-gratings, y-	I	10 x 10 µm	Quarz	8 x 8 mm²	a-Si	25	Designed for

		Linewidth/Pitch - Standard	160, 200, 230, 260, 300, 500, 700, 1000, 4000 nm CD: 80 nm to 2µm	gratings, Linewidthstructur, x- y- gratings and circular gratings							using in DUVM, CLSM (also usable in AFM and SEM)

Home

No. ***Nr.***	**Manufacturer** Hersteller	**Model** ***Modell***	**Measurement range** ***Messbereich***	**Description** ***Beschreibung***	**Image**	**Lateral Measurement Range** ***lateraler Messbereich***	**Substrate** ***Substrat***		**Coating** ***Beschichtung***		**Remarks** ***Bemerkungen***
			/nm			/µm	Material *Material*	Dimension *Dimension* */nm*	Material *Material*	Thickness *Dicke* /nm	
	F) **3D-Standards**	***F)*** ***3D-Normal***									
F01.	3D-Nano-Normal,				**I**						

Home

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			/nm			/µm	Material *Material*	Dimension *Dimension* */nm*	Material *Material*	Thickness *Dicke* /nm	
	G) Flatness	***G) Ebenheit***									
G01.	SiMetricS	Flatness Standard Type FtS	PV < 110/65	Flat ref. area	**I**	£ 10 mm x 10 mm/ £ 5 x 5	Si	15 x 15 x 6	SiO_2		
G02.	EU-Standard	partly available from Nanosensors	PV < 10	Flat ref. area	**I**	£ 250 x 250	Quartz	5 x 7 x 2	Cr	100	

Home

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			/nm			/µm	Material *Material*	Dimension *Dimension* */nm*	Material *Material*	Thickness *Dicke* /nm	
	H) Thickness	***H) Schichtdicke***									
H01.	Inst. Mikro elektroden	SiO2 on Si	7, 20, 70, 300, 800	3 lines with different width 5, 30, and 100 µm	**I**	£ 4000	SiO2/Si	5 x 7	Cr	100	

Home

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			/nm			/µm	Material *Material*	Dimension *Dimension* */nm*	Material *Material*	Thickness *Dicke* /nm	
	I) Roughness	***I) Rauheit***									
I01.	VLSI	RAS-90, 220, 440, 900, 2250, 4700	9, 22, 44, 90, 225, 470	4 separate fields with 6, 20, 60, and 200 µm pitch rectangular profile	**I**	£ ~5000 x 4500	Silicon die on Quartz	25 x 25 x 6			Roughness standard for Ra

Home

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			/nm			/µm	Material *Material*	Dimension *Dimension* */nm*	Material *Material*	Thickness *Dicke* /nm	
	J) **Critical Dimension**	***J)*** ***Kritische Dimension***									
J01.	Pelco		1, 2, 5, 10µm	central area comprises four line patterns	**I**	£ 180	Silicon	4.8 x 4.5			for SEM
J02.	Supracon	Nanoscale CD - Standard	CD: 50, 100, 150, 200, 300 und 800 nm	6 grups of 5 CD-Si-bars, space between bars 1µm, depth: 250 nm	**I**	10 x10	Si	8 x 8 mm²			Designed for using in AFM (also usable in SEM)

Home

	K) **Tip Radius, Angle, Parallelity**	*K)* ***Spitzenradius, Winkel, Parallelität***									
K01.	SiMetricS	Type 1	4 gratings with the periods: 0.8; 1.0; 2.0; 2.5 µm	***Triangular profile:* GrT70** (angle 70.52°) ***Triangular profile:* GrT109** (angle 109.48°)	**I**	£	Si	10 x 10	SiO_2		
K02.	SiMetricS	Type 2	1 grating with the period: 8 ***or*** 25 µm	***Trapezoidal profile:* GrTz55** (Trapezoidal angle 54.74°) Depth: 3 µm for 8 µm period Depth: 11 µm for 25 µm period ***Triangular profile:* GrT70** (angle 70.52°) ***Triangular profile:* GrT109** (angle 109.48°) ***Arched profile:* GrA**	**I**	£	Si	10 x 10	SiO_2		
K03.	SiMetricS	Type 3	1 grating with the period: 8 ***or*** 25 µm	***Rectangular profile:* GrRw** Depth: 1 µm for 8 µm period Depth: 5 µm for 25 µm period	**I**	£	Si	10 x 10	SiO_2		
K04	SiMetricS	Type 4	8 gratings with the periods: 4; 8; 20; 40; 80; 200; 400; 800 µm	***Rectangular profile:* GrRd** Depth: 90 nm or 3,4 µm	**I**	£	Si		SiO_2		

Home

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			/nm			/µm	Material *Material*	Dimension *Dimension* */nm*	Material *Material*	Thickness *Dicke* /nm	
	L) Contour, Profile	***L) Kontur, Profil***									
L01.	PTB	Micro contour artefact	100 , 250, 500, 1000 ,2000 µm	profile of cylindrical (180°), and prismatic elements (45°, 60°, 80°)	**I**	0.5 x 0.5 to 18 x 3	Steel	50 x 3 x 15			Test and comparison of optical and tactile micro sensors

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			/nm			/µm	Material *Material*	Dimension *Dimension* */nm*	Material *Material*	Thickness *Dicke* /nm	
	M) **Diameter, Poundness**	***M)*** ***Durchmesser, Zylindrizität***									
M01	PTB	Micro hole artefact	Ø 100 µm x 2.4 mm	cylinder	**I**	150	Steel	10 x 10			Test of tactile micro sensors

Home

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			/nm			/µm	Material *Material*	Dimension *Dimension* */nm*	Material *Material*	Thickness *Dicke* /nm	
	N) **Probing Force**	***N)*** ***Antastkraft***									
N01.	SiMetricS	Probing force standard Type FC	0.005 – 1.0 mN/µm	cantilever for probing with stylus intruments, indenters etc.	**I**		Si	15 x 15	SiO_2		
N02.	SiMetricS	Probing force standard Type FB	0.3 – 5.5 mN/µm	cantilever fixed at both sides for probing with stylus intruments, indenters etc.	**I**		Si	15 x 15	SiO_2		

Home

aa) available on 200 mm Si wafer

bb) available on 200 and 300 mm wafer

cc) optional mounted on 25 x 25 x 0,6 mm ^{3} Quartz bloc or 100 - 200 mm Silicon wafer

dd) standard is accompanied by a STR10 of same height

ee) standard is accompanied by a STR2 of same height

Home

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Manufacturer / Distributor and contact address

A01. SiMetricS GmbH, Siliziumkomponenten für die Messtechnik, Am Südhang 5, 09212 Limbach-Oberfrohna and J. Fruehauf, S. Kroenert, U. Brand, R. Krueger-Sehm: Attainable precision of silicon dimensional standards. Proc. Euspen Conf. (2004),

joachim.fruehauf@e-technik.tu-chemnitz.de and < www.SiMetricS.de >

A02. PELCO INTERNATIONAL, P.O. Box 492477, Redding, CA 96049-2477, USA;< www.pelcoint.com/index >

A03. Veeco GmbH, D-85716 Unterschleißheim, Germany; < www.veeco-europe.com > or < www.veeco.com >

A04. VLSI Standards Inc.; 3087 North First Street; San Jose, CA 95134-2006, USA; < www.vlsistd.com >

A05. See A04.

A06. Halle Präzisions-Kalibriernormale GmbH, Im Bühfeld 12, D-31234 Edemissen, Germany; Fax: +49 5373 7669

A07. Meracia Technika- Technocentrum, P.O. Box 249, SK 84000 Bratislava, Slovakia; Fax: +42 17 6542 6143

A08. PTB Cu Depth Setting Standards, PTB, AG 5.11, Bundesallee 100, 38116 Braunschweig;

< www.ptb.de/de/org/5/51/511/index.htm > and U. Brand, G. Hinzmann, H. Schnädelbach, C. Feist, P. Stuht, R. Krüger-Sehm, V. Jäger: Rückführbare Präzisions-Tiefen-Einstellnormale für Messbereiche von 1 µm bis 1 mm (Traceable precision depth setting standards for measurement ranges from 1 µm to 1 mm). Technisches Messen 66, 12 (1999), 496-503. uwe.brand@ptb.de

B01. MikroMasch, Narva mnt. 13, 10151 Tallina, Estonia; < www.mikromasch.com >

B02. See B01.

B03. NTT Advanced Techn. Corp., 3-1 Morinosato-Wakamiya, Atsugi, Kanagawa 243-0198, Japan; < www.keytech.ntt-at.co.jp >

C01. See B01.

C02. See A04.

C03. See A04.

C04. See A04.

C05. See A04.

C06. EU project "Transfer Standards for Calibration of SPMs" Information may be obtained from the coordinator Dr. Jørgen Garnæs, DFM, Lyngby, Denmark (JG@dfm.dk). NANOSENSORS, IMO-Building, Im Amtmann 6, D-35578 Wetzlar-Blankenfeld, Germany; <www.nanosensors.com >

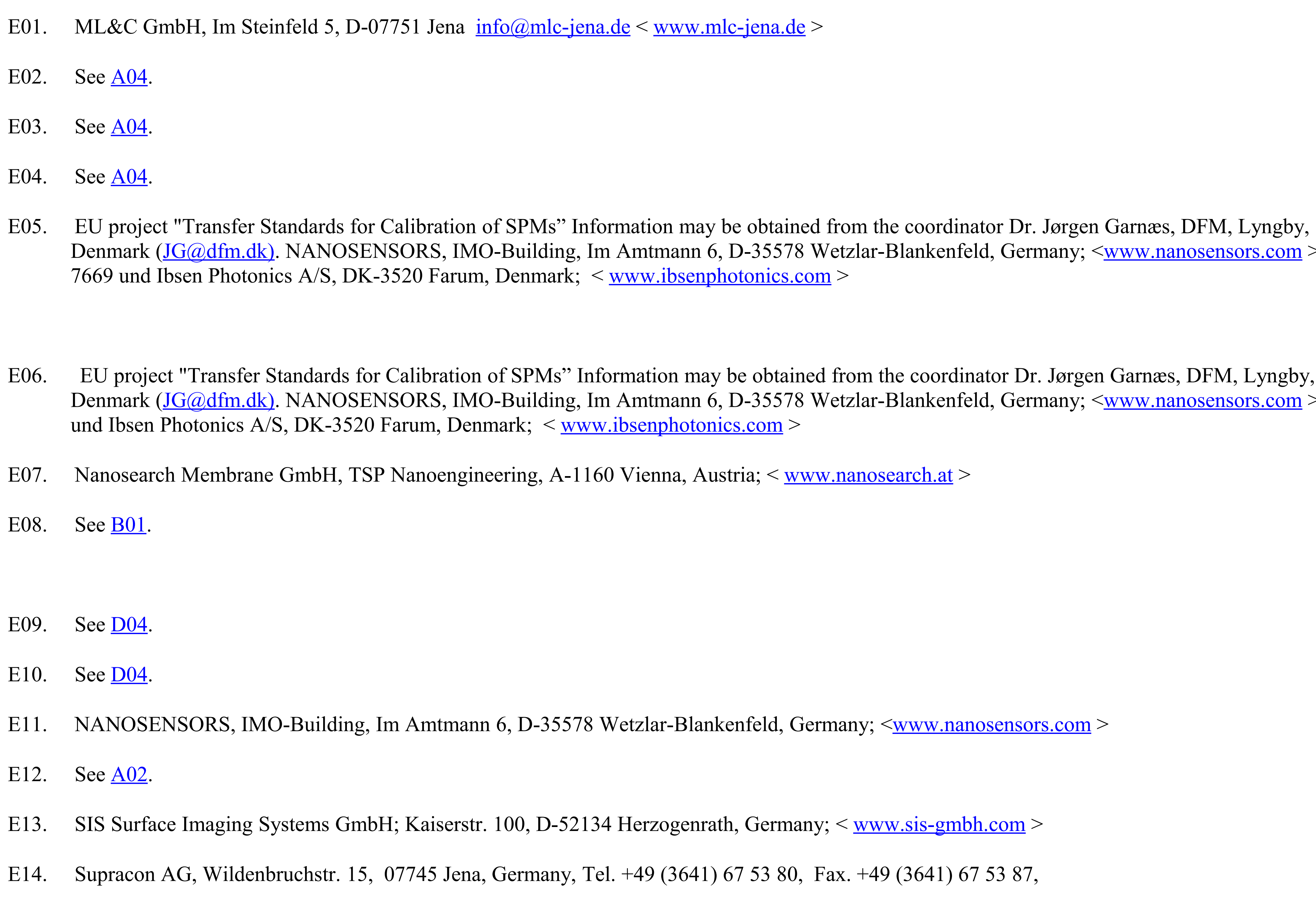
D01. SiMetricS GmbH, Siliziumkomponenten für die Messtechnik, Am Südhang 5, 09212 Limbach-Oberfrohna

joachim.fruehauf@e-technik.tu-chemnitz.de and < www.SiMetricS.de >

D02. Advanced Surface Microscopy, Inc. 6009 Knyghton Rd; Indianapolis, IN 46220, USA; < www.asmicro.com >

D03. See B01.

D04. Moxtek Inc. Orem, UT 84057, USA; < www.moxtek.com >



E01. ML&C GmbH, Im Steinfeld 5, D-07751 Jena info@mlc-jena.de < www.mlc-jena.de >

E02. See A04.

E03. See A04.

E04. See A04.

E05. EU project "Transfer Standards for Calibration of SPMs" Information may be obtained from the coordinator Dr. Jørgen Garnæs, DFM, Lyngby, Denmark (JG@dfm.dk). NANOSENSORS, IMO-Building, Im Amtmann 6, D-35578 Wetzlar-Blankenfeld, Germany; <www.nanosensors.com > 7669 und Ibsen Photonics A/S, DK-3520 Farum, Denmark; < www.ibsenphotonics.com >

E06. EU project "Transfer Standards for Calibration of SPMs" Information may be obtained from the coordinator Dr. Jørgen Garnæs, DFM, Lyngby, Denmark (JG@dfm.dk). NANOSENSORS, IMO-Building, Im Amtmann 6, D-35578 Wetzlar-Blankenfeld, Germany; <www.nanosensors.com > und Ibsen Photonics A/S, DK-3520 Farum, Denmark; < www.ibsenphotonics.com >

E07. Nanosearch Membrane GmbH, TSP Nanoengineering, A-1160 Vienna, Austria; < www.nanosearch.at >

E08. See B01.

E09. See D04.

E10. See D04.

E11. NANOSENSORS, IMO-Building, Im Amtmann 6, D-35578 Wetzlar-Blankenfeld, Germany; <www.nanosensors.com >

E12. See A02.

E13. SIS Surface Imaging Systems GmbH; Kaiserstr. 100, D-52134 Herzogenrath, Germany; < www.sis-gmbh.com >

E14. Supracon AG, Wildenbruchstr. 15, 07745 Jena, Germany, Tel. +49 (3641) 67 53 80, Fax. +49 (3641) 67 53 87,

info@supracon.com, < www.supracon.com >

F01. M. Ritter, Bundesanstalt für Materialforschung und-prüfung (BAM), Unter den Eichen 87, 12205 Berlin, info@bam.de < www.bam.de >

G01. See D01.

G02. EU project "Transfer Standards for Calibration of SPMs" Information may be obtained from the coordinator Dr. Jørgen Garnæs, DFM, Lyngby, Denmark (JG@dfm.dk). NANOSENSORS, IMO-Building, Im Amtmann 6, D-35578 Wetzlar-Blankenfeld, Germany; <www.nanosensors.com >

H01. Institute for Microelectronics Stuttgart, Allmandring 30 a, D-70569 Stuttgart, Germany;< www.ims-chips.de >

I01. See A04.

J01. See A02.

J02. See E14.

K01. See D01.

K02. See D01.

K03. See D01.

K04. See D01.

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Home