

AVALIAÇÃO 3D SEM CONTATO DE SUPERFÍCIES EM PENETRADORES DE DUREZA

Medição ótica da topografia da superfície do penetrador de diamante

Medição Dimensional

Dimensional Surface measuring technology

Optical Systems

Confocal

Interferometry

Focus
Variation

Vision
Systems

3D

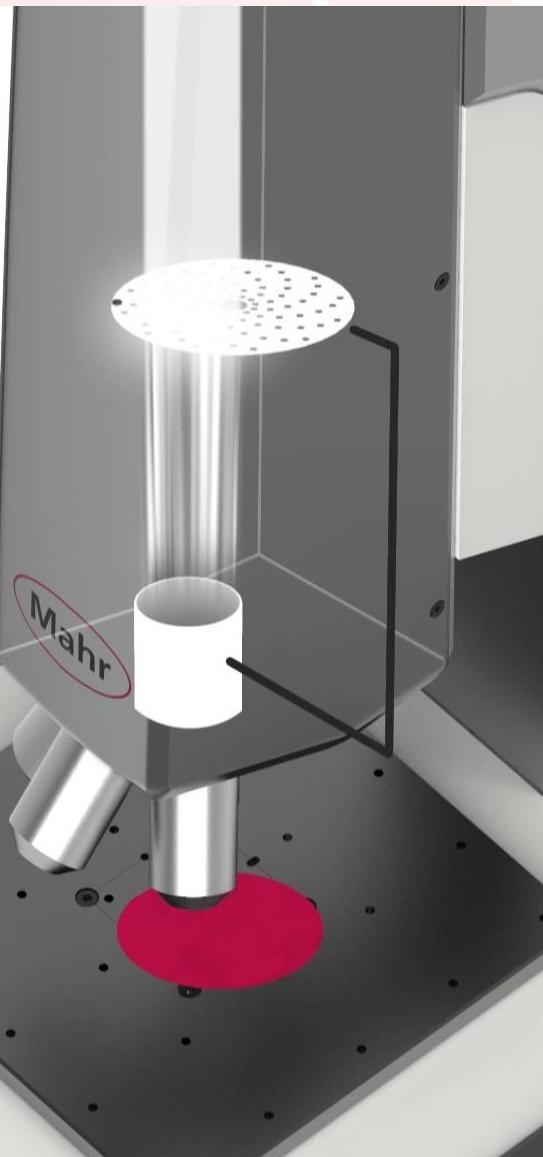
2D

Tactile Systems

AFM*

SEM*

AFM = Atomic Force Microscope
SEM = Scanning Electron Microscope

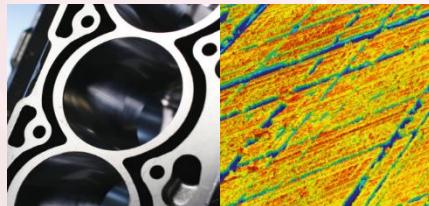


MarSurf CM

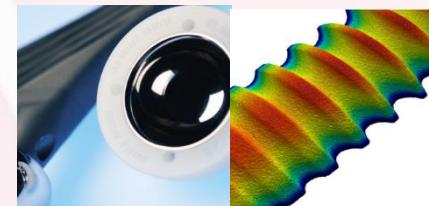
- Ensaio não destrutivo e independente de material
- Nenhuma preparação de amostra necessária
- A mais alta qualidade de dados com todas as ampliações
- Maior velocidade de medição
- Grande portfólio de produtos (padrão, soluções portáteis, soluções automatizadas)
- A mais alta transparência (Fair Data Sheet, especificação única)
- Know-how, serviços de consultoria
- Fornecedor de tecnologia de medição tátil e óptica

Mais informações sobre a Fair Data Sheet podem ser encontradas no site da Initiative [Fair Data Sheet](#).

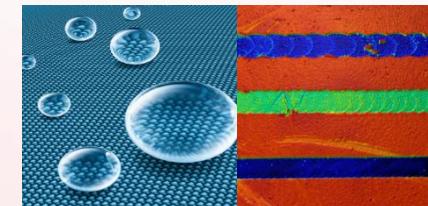
Aplicações – Segmentos Industriais



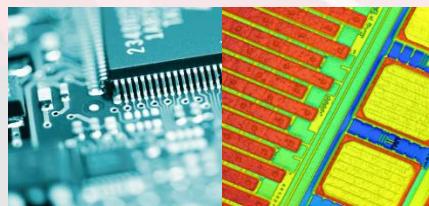
Automotive



Medical



Material Science



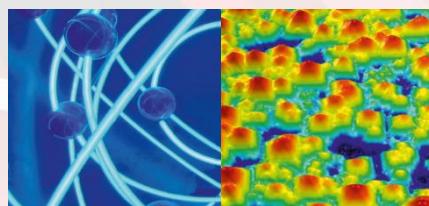
Semiconductor



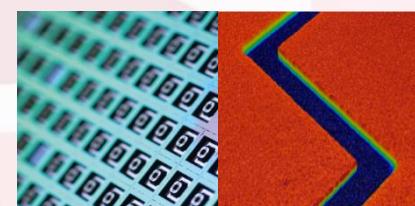
Security & Printing



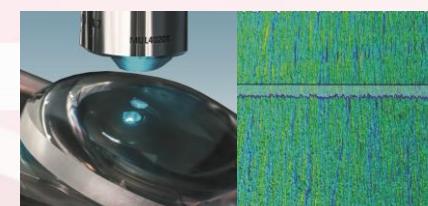
Tools



Energy



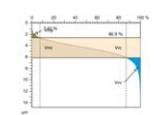
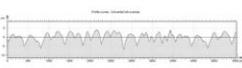
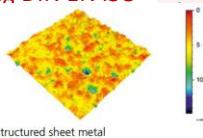
Microsystems



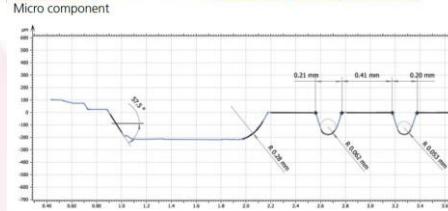
Optical

Aplicações – Tarefas de Medição

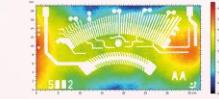
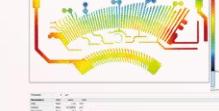
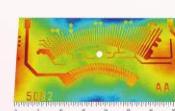
2D-/3D Roughness according DIN EN ISO



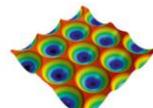
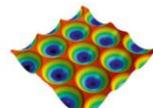
Form, Contur



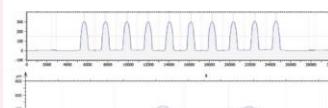
Flatness and coplanarity



Volume

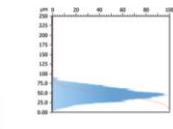
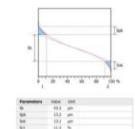
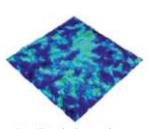
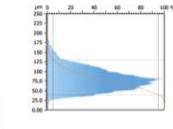
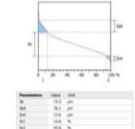
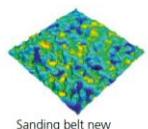


Layer thickness

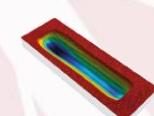
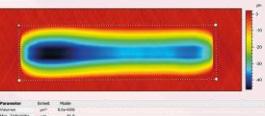


Paste on ceramic substrate

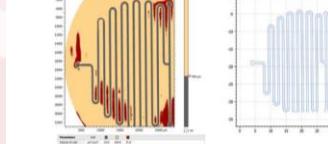
Tribology, bearing and functional surfaces



Wear

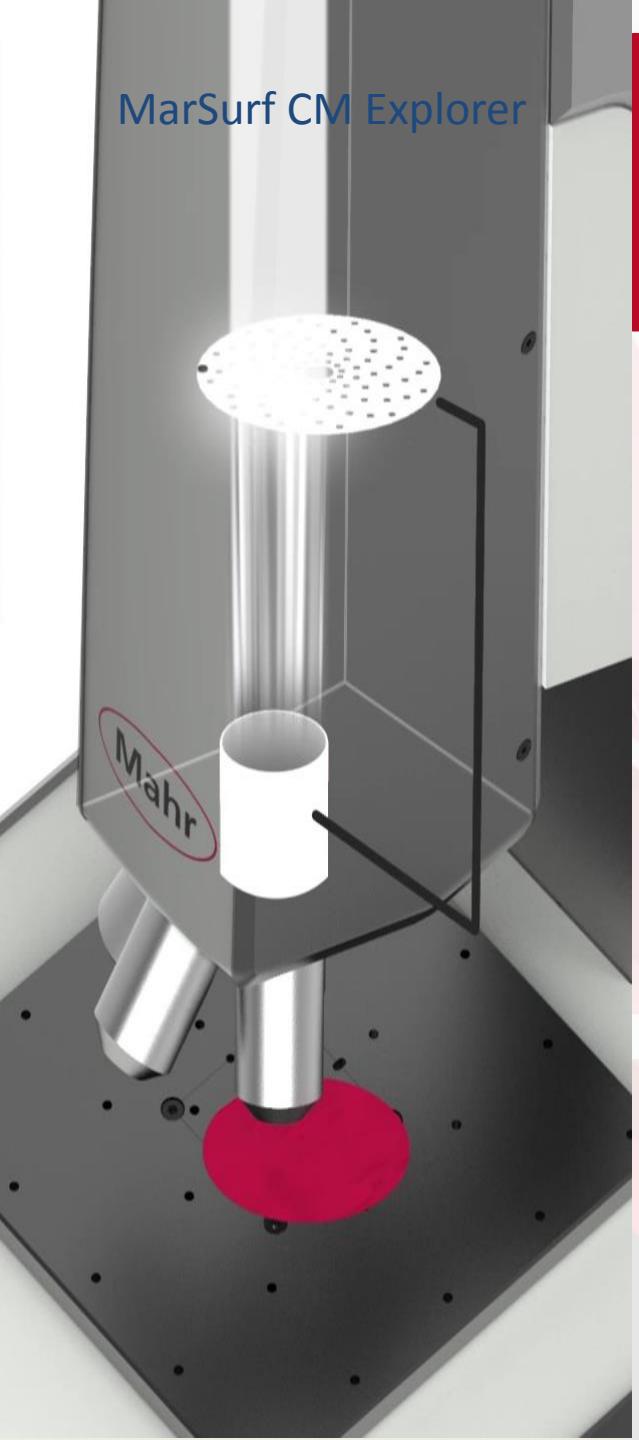


Form



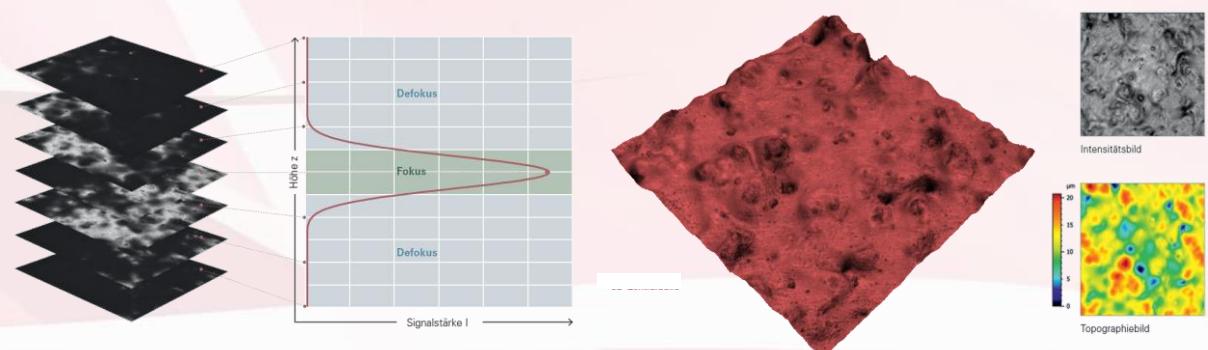
Channels in a microfluid chip





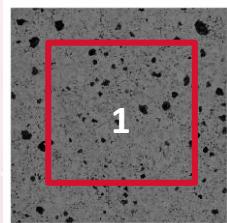
Princípio de funcionamento “3D”

- Semelhante à tomografia computadorizada, a superfície é capturada opticamente camada por camada.
- O computador mescla as imagens da camada individual em uma imagem de altura 3D da amostra com precisão **nanométrica**.

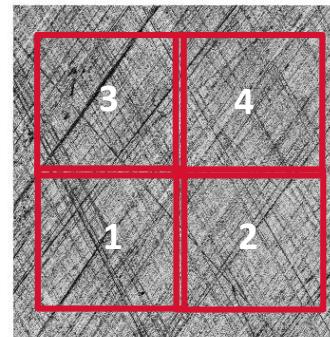


...para mais detalhes

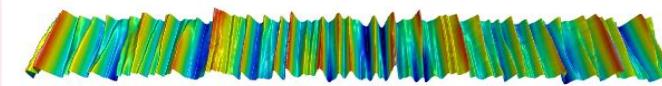
Data acquisition – Stitching function



Single Image
2-5 seconds



2 x 2 Stitching
~25 seconds



7 x 1 Stitching
~40 seconds



Initiative **Fair** ::
Data
Sheet

Objectives

	3200S	1600S	800L	800S	800XS	320L	320S	320XS ¹	160L	160S	160XS ¹
Objective magnification	5x	10x	20x	20x	20x	50x	50x	50x	100x	100x	100x
Measuring area x,y (µm)	3200	1600	800	800	800	320	320	320	160	160	160
Measuring area x × y (mm ²)	10.24	2.56	0.64	0.64	0.64	0.1024	0.1024	0.1024	0.0256	0.0256	0.0256

Métodos de Medição de Dureza

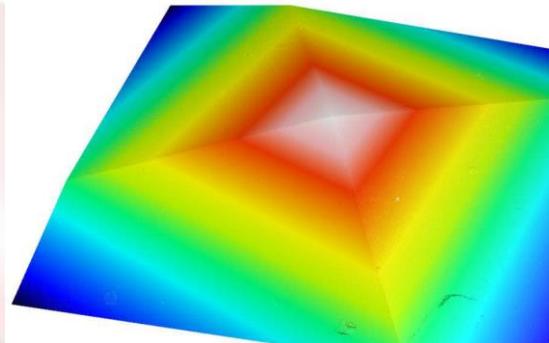
Existem três métodos mundialmente usados de medição de dureza:

Vickers → usa um penetrador em formato de pirâmide.

Rockwell → usa um penetrador de diamante cônico ou uma esfera de aço

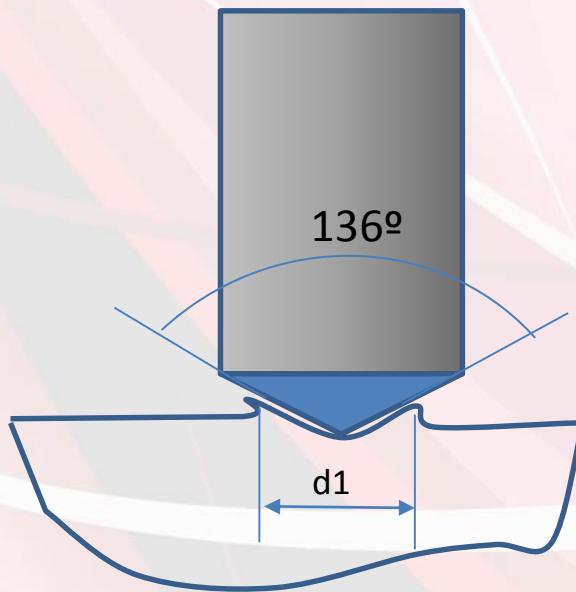
Brinell → usa um penetrador esférico

O valor da dureza é calculada pelo tamanho da indentação produzida pela carga. Quanto menor a marca deixada, mais duro o metal.



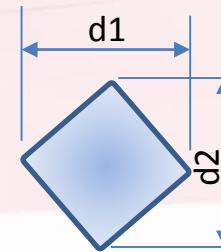
Detalhes do ensaio Vickers

Indentação Vickers



Medição da impressão das diagonais

$$\frac{d = d_1 + d_2}{2}$$



A dureza Vickers se baseia na resistência que o material oferece à penetração de uma pirâmide de diamante de base quadrada e ângulo entre faces de 136°, submetida a determinada carga. O valor de dureza Vickers (HV) é o quociente da carga aplicada pela área de impressão deixada no corpo ensaiado.

Detalhes do ensaio Vickers

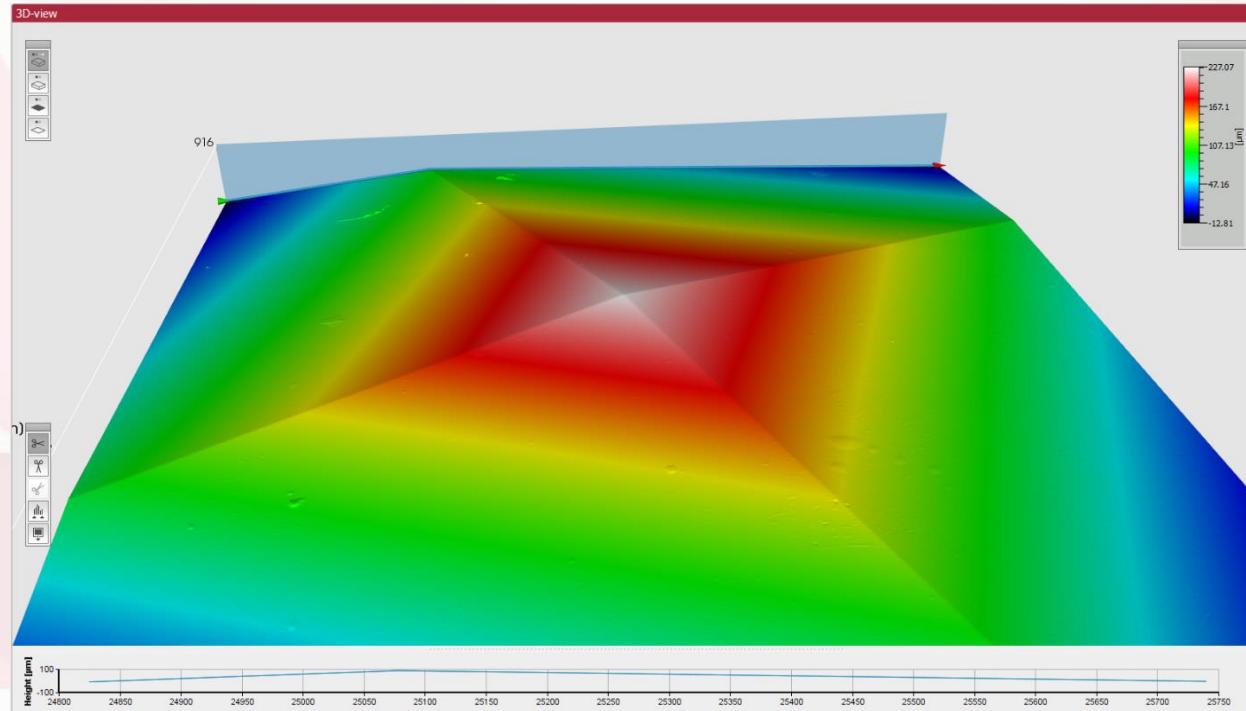
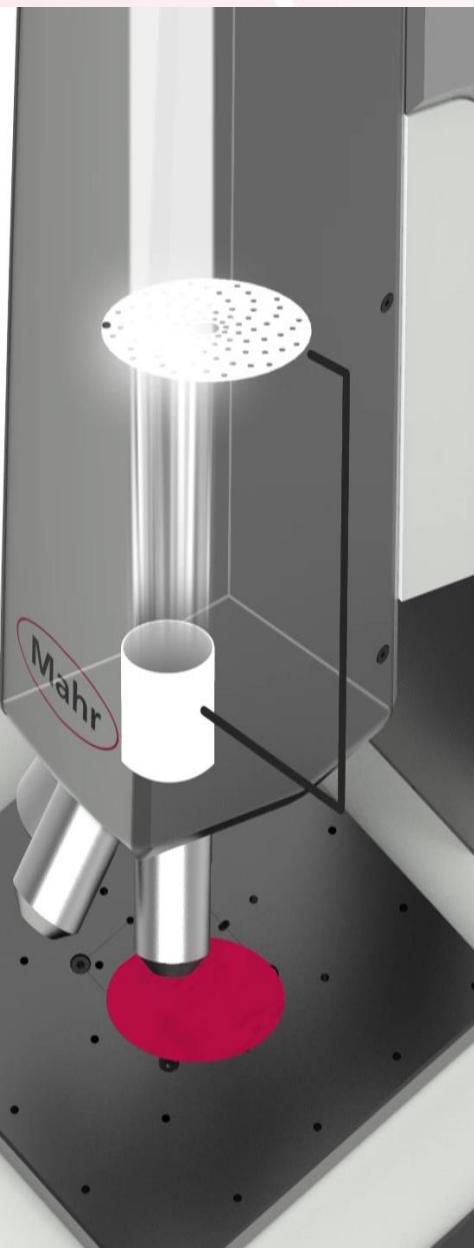
Faixas típicas da superfície de contato de um indentador Vickers sob várias forças de teste

Tipo de teste	Força* de teste	Profundidade da Indentação**	Largura da Diagonal** (um)
Dureza	49.03 - 980.7	14.50 - 137.5	101.5 - 962.8
Dureza com baixa força	1.961 - 29.42	2.900 - 23.82	20.30 - 166.8
Microdureza	0.9807-0.0987	2.857*** - 4.350	20.00*** - 30.45
Nano-indentação	Não especificado na ISO 14577-1		

*Recomendação na norma ISO 6507-1

** Dureza adotada como 200 a 900 HV

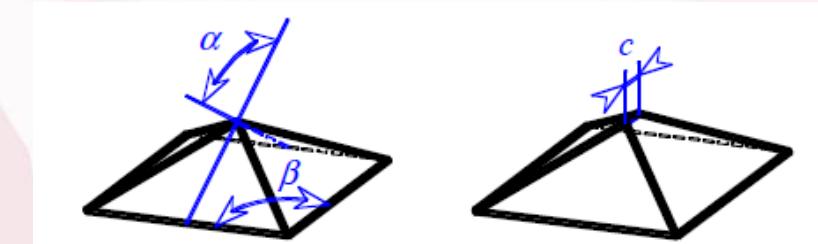
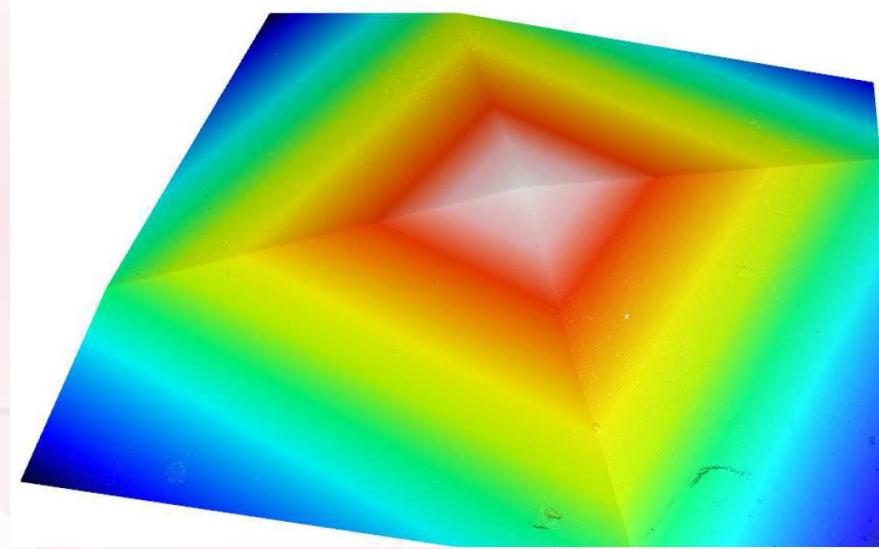
*** Limite inferior da largura da diagonal na ISO 6507-1



Geometria do Penetrador Vickers

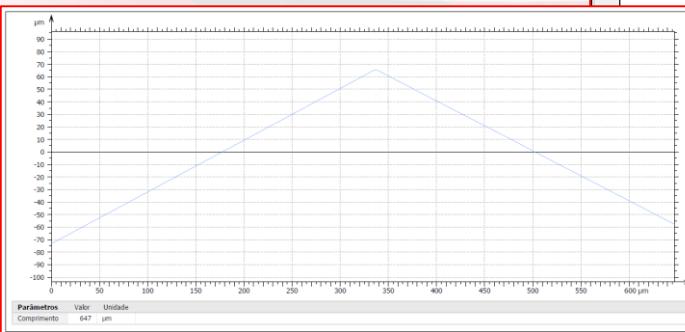
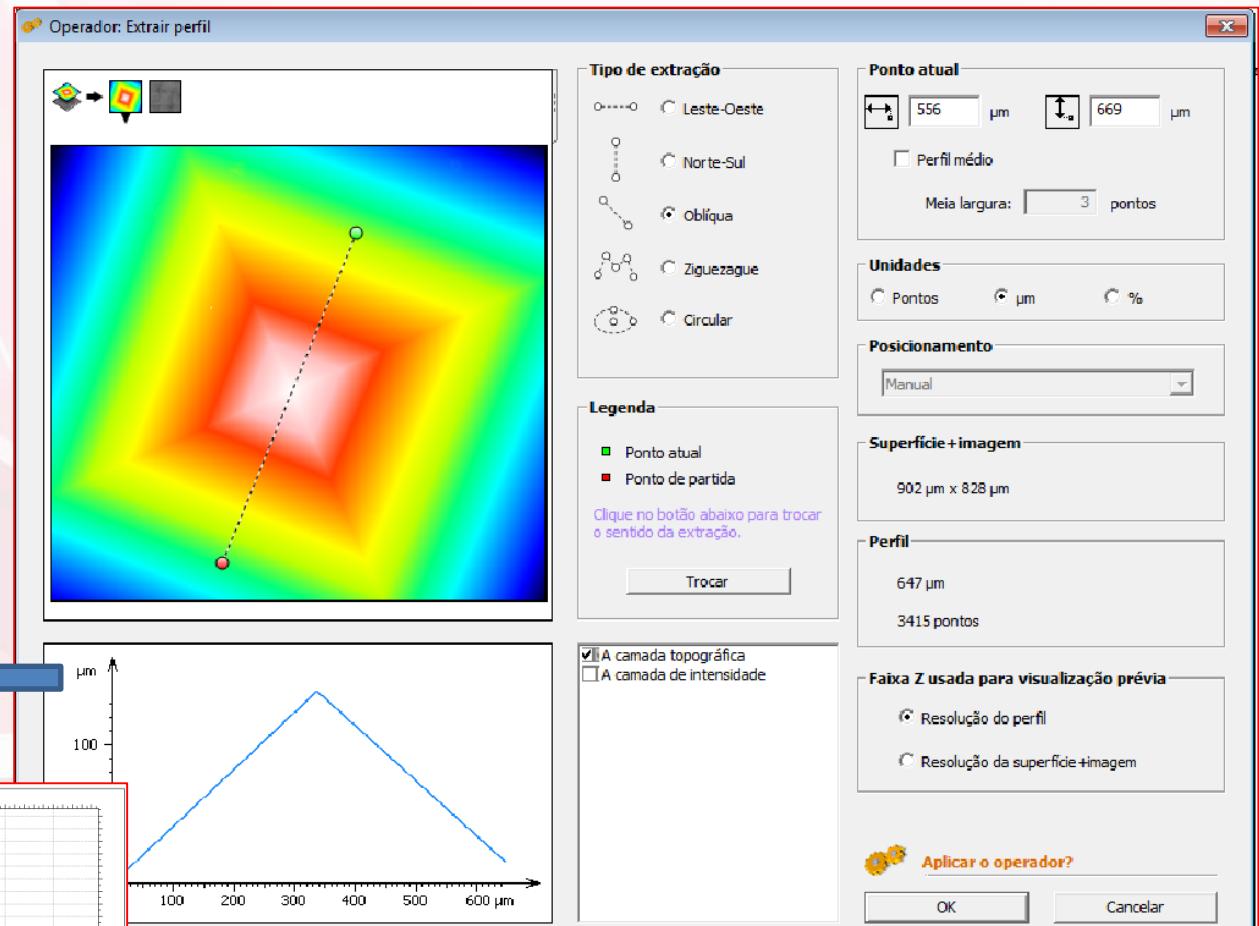
A geometria da pirâmide Vickers é definida com o ângulo entre as faces opostas de 136 graus. Para garantir a precisão de sua geometria, a ISO 6507-3 exige a verificação dos itens a seguir:

- a) O ângulo entre as faces opostas (α) deve ser $136 \pm 0,1^\circ$,
- b) A linha de conjunção entre as faces opostas deve ser menor que 0,001 mm, 0,0005 mm e 0,00025 mm para a faixa de força de teste de $F \geq 49,03$ N, $1,961 \text{ N} \leq F < 49,03$ N e $0,09807 \text{ N} \leq F < 1,961$ N respectivamente.
- c) O ângulo do canto da base quadrada da pirâmide (β) deve ser $90 \pm 0,2^\circ$.



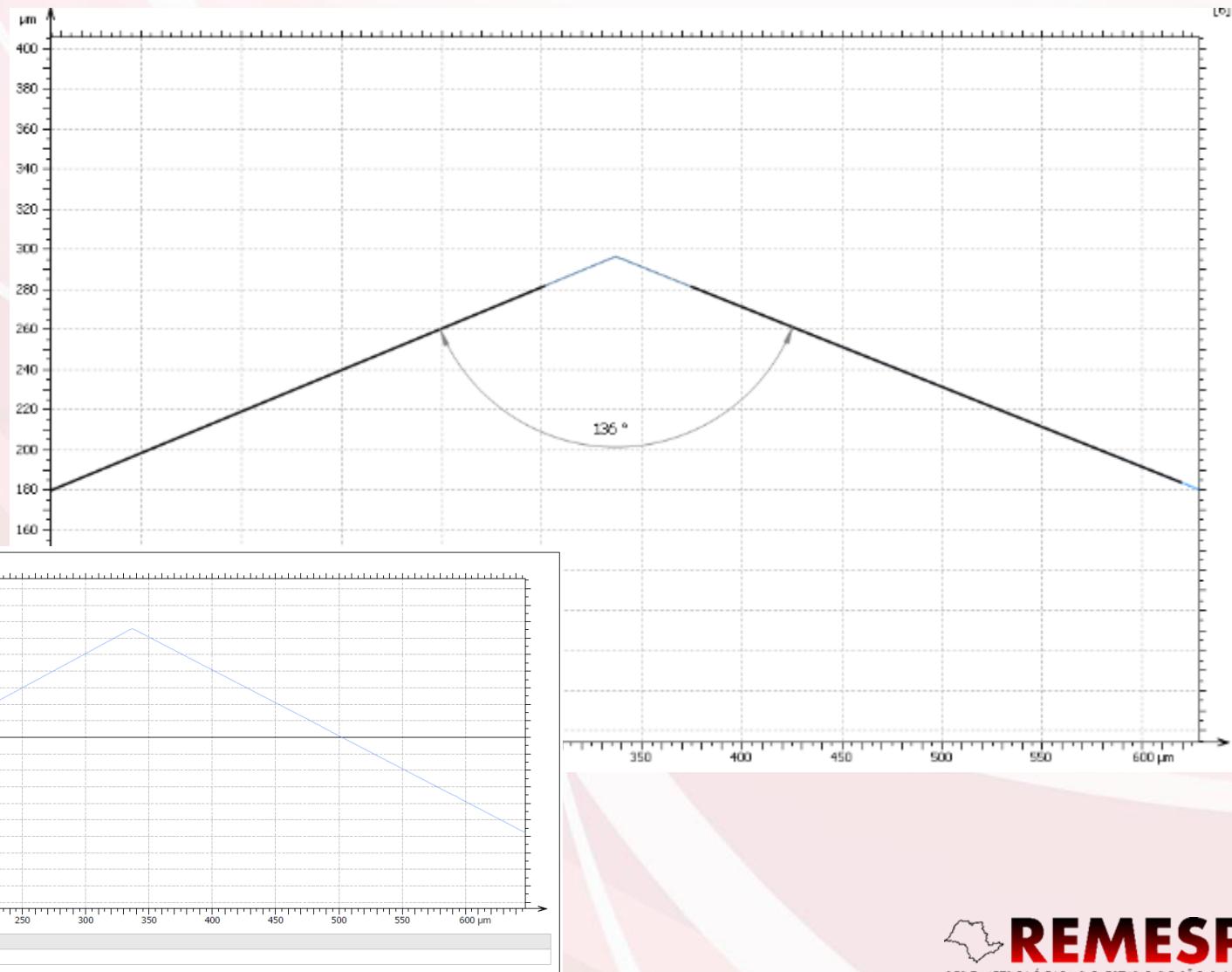
Fonte: Takagi et al, 2006

Ângulo entre as faces de 136º



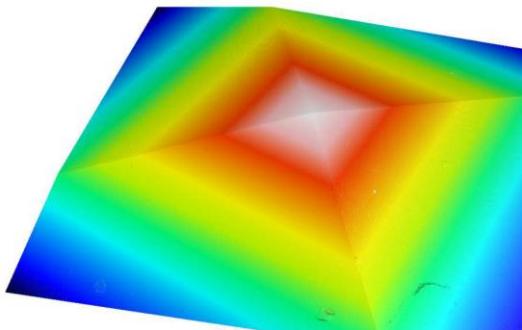
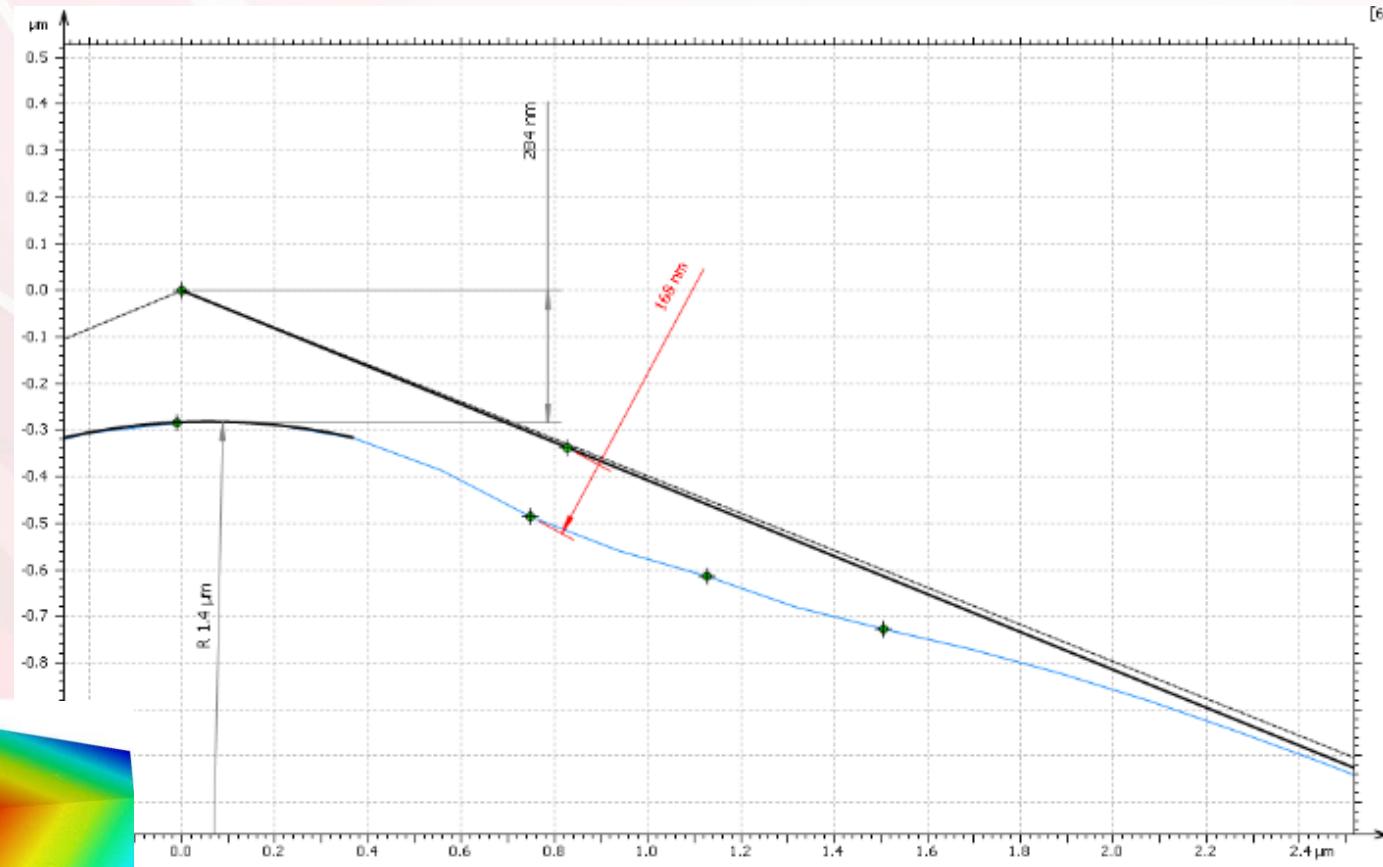
Ângulo entre as faces de 136º

136º

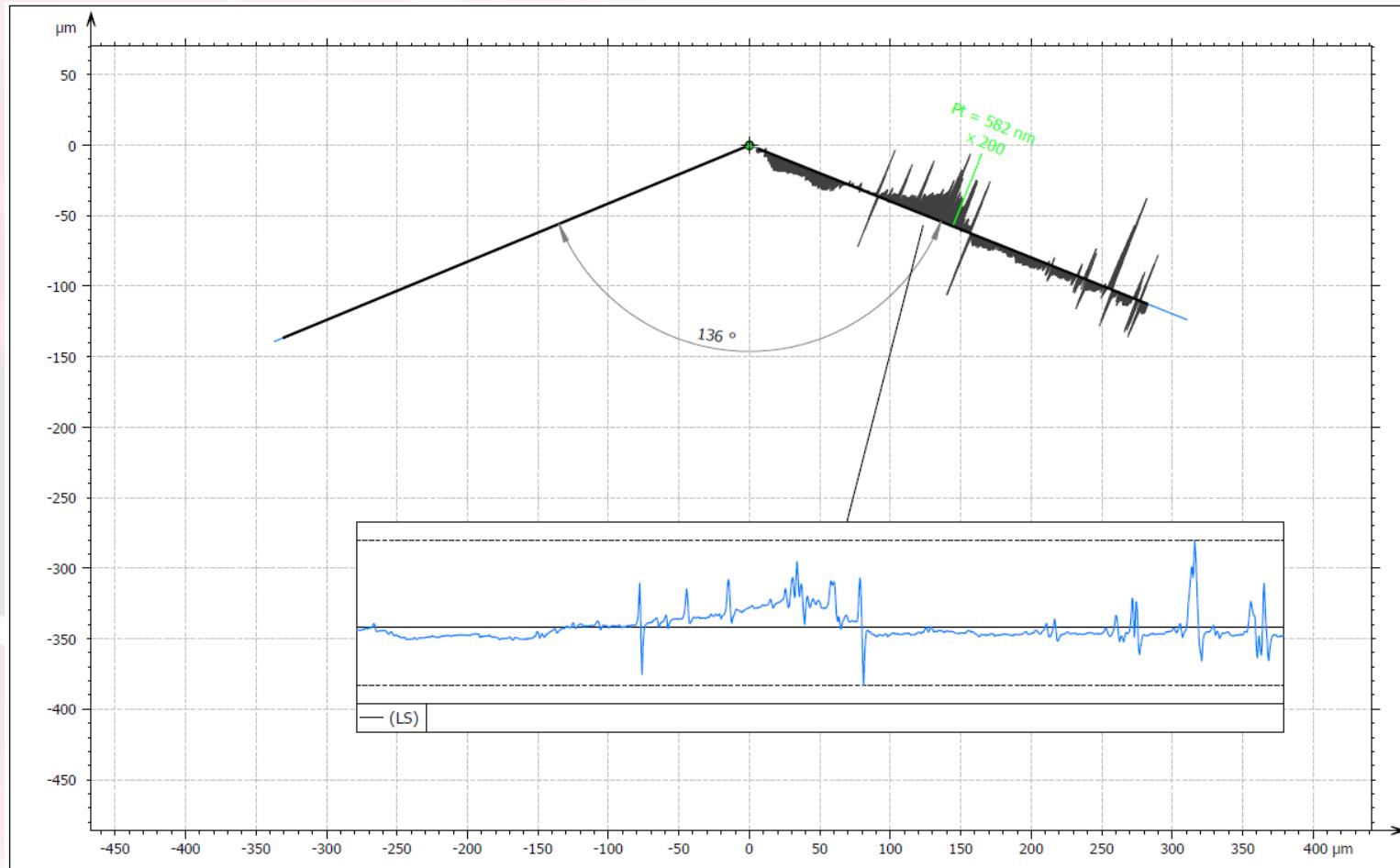


Ângulo entre as faces de 136º

Lente com
ampliação de
50x:

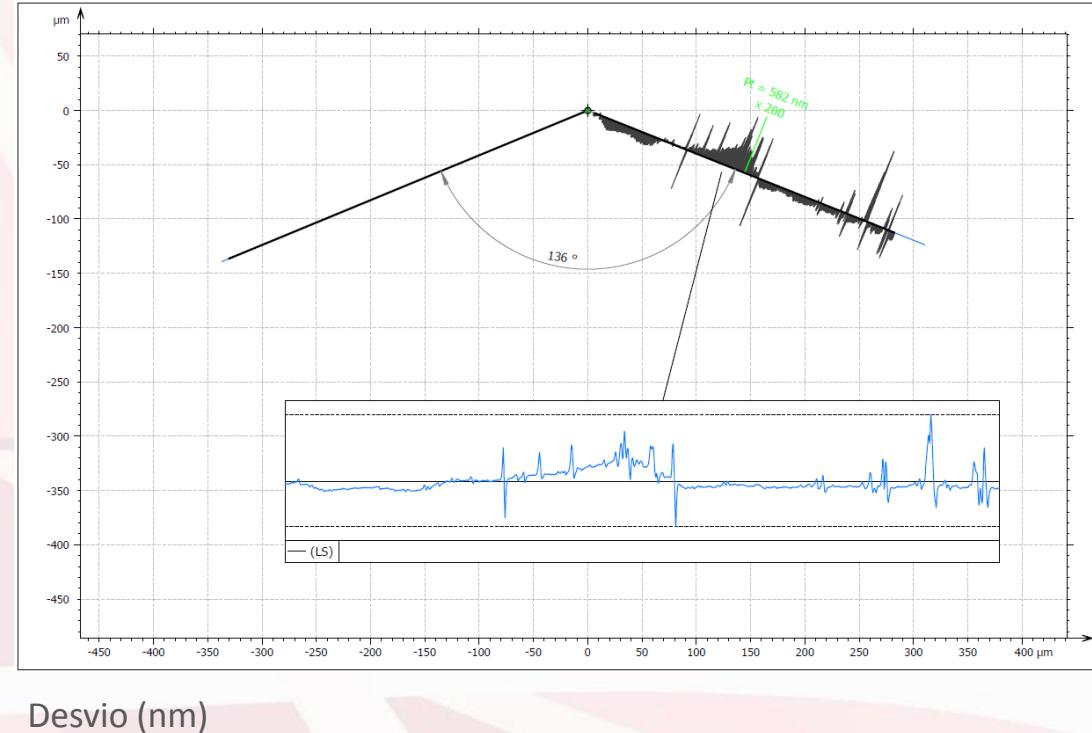


Retitude das faces



Exportar os dados (.txt)

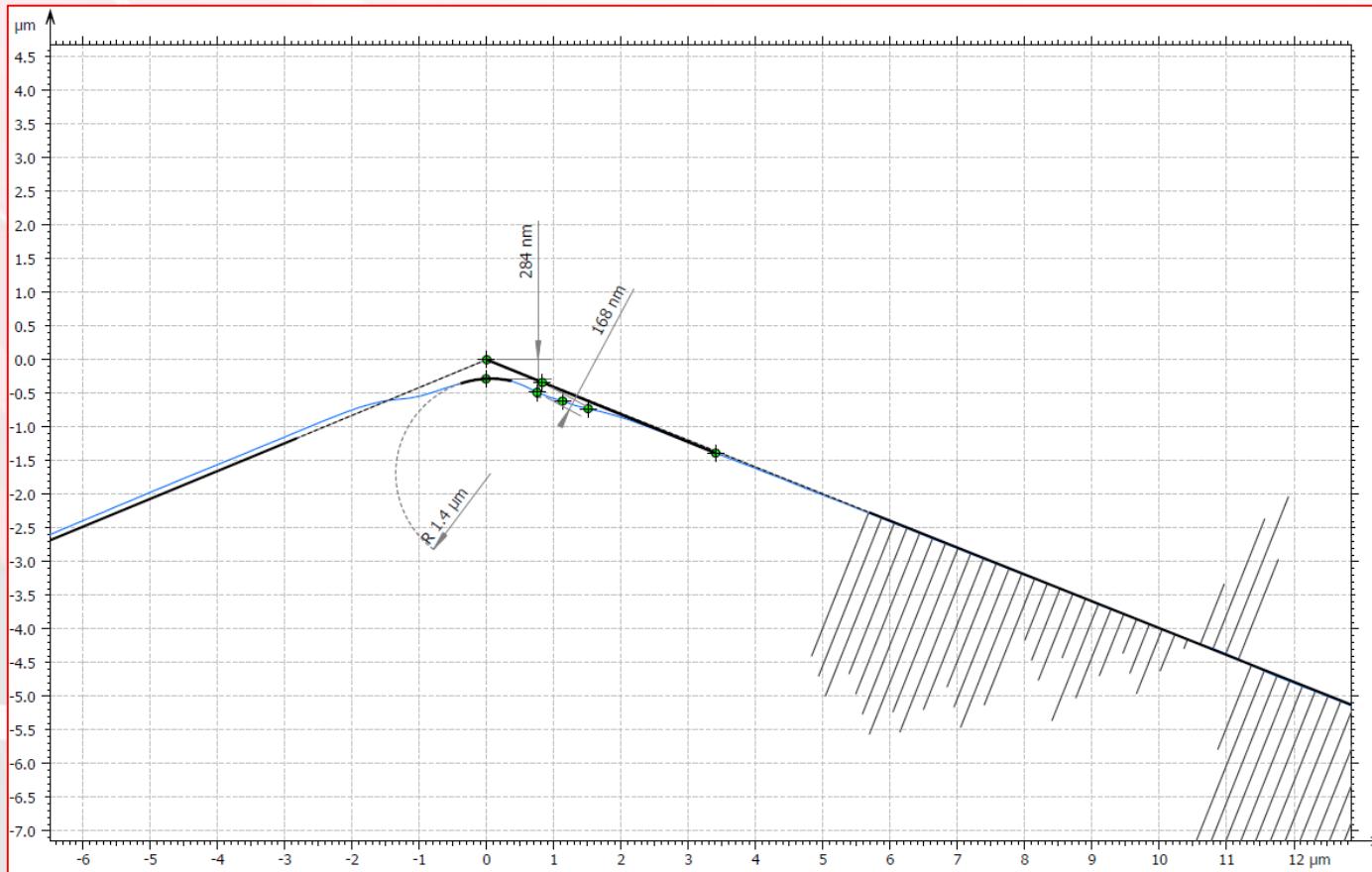
X (μm)	Y (μm)	Desvio (μm)
37.07334764	-14.83782392	-0.05127880469
37.26292983	-14.91103022	-0.04906095607
37.45251201	-14.98789684	-0.0502431001
37.64209419	-15.06476345	-0.05142524412
37.83167637	-15.13796975	-0.0492073955
38.02125855	-15.21483637	-0.05038953952
38.21084073	-15.29170298	-0.0515168355
38.40042292	-15.36490928	-0.04935383493
38.5900051	-15.4417759	-0.0503597895
38.77958728	-15.51864251	-0.05171812297
38.96916946	-15.59184881	-0.04950027435
39.15875164	-15.66871543	-0.05068241838
39.34833382	-15.74558204	-0.0518645624
39.533156	-15.82244866	-0.05204670642
39.72749819	-15.89565496	-0.05082885781
39.91708037	-15.96886126	-0.0486110819
40.0666255	-16.0406875	-0.0493956057
40.29624473	-16.11884417	-0.04775530459
40.485301	-16.19580079	-0.04875744861
40.67540899	-16.26900709	-0.04653959999
40.86599128	-16.34221339	-0.0452175128
41.05457346	-16.41908	-0.0455038954
41.24415564	-16.4922863	-0.04328604678
41.43373782	-16.56915292	-0.0444681908
41.63332	-16.64601953	-0.04565032483
41.81290218	-16.72288615	-0.04683247885
42.00248437	-16.79609245	-0.04461463023
42.19206555	-16.87295906	-0.04579677425
42.38164873	-16.95714631	-0.05377890356
42.57123091	-17.03767324	-0.05836104023
42.76081309	-17.11453986	-0.05954318425
42.95039527	-17.18408584	-0.05392534299
43.13997746	-17.26095246	-0.05510748701
43.32955964	-17.33781907	-0.05628963104



Desvio (nm)

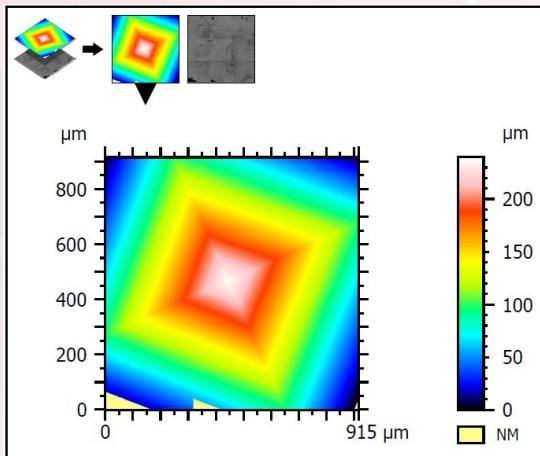


Exportar os dados (.txt)

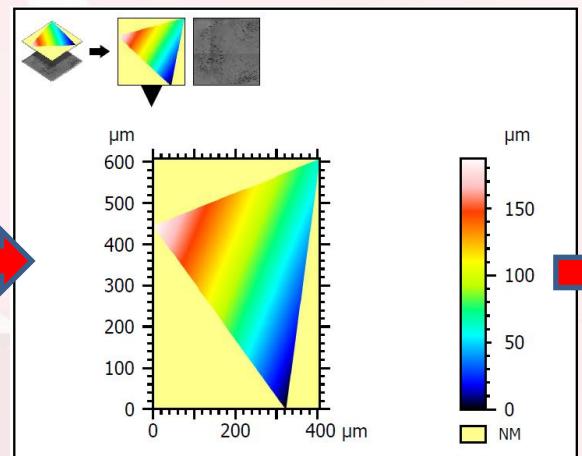


Avaliação da Rugosidade 3D e 2D

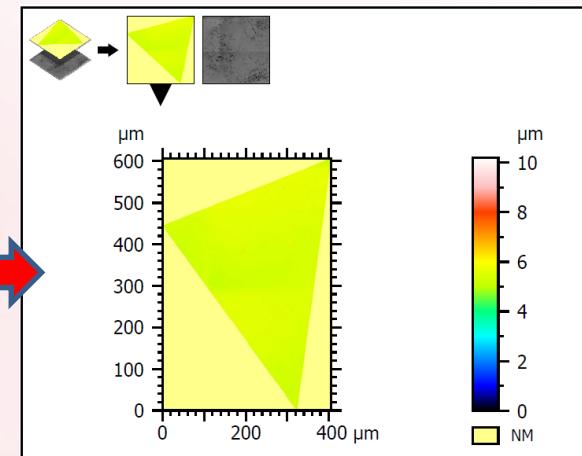
Dados iniciais



Seleção de área



Nivelamento dos pontos

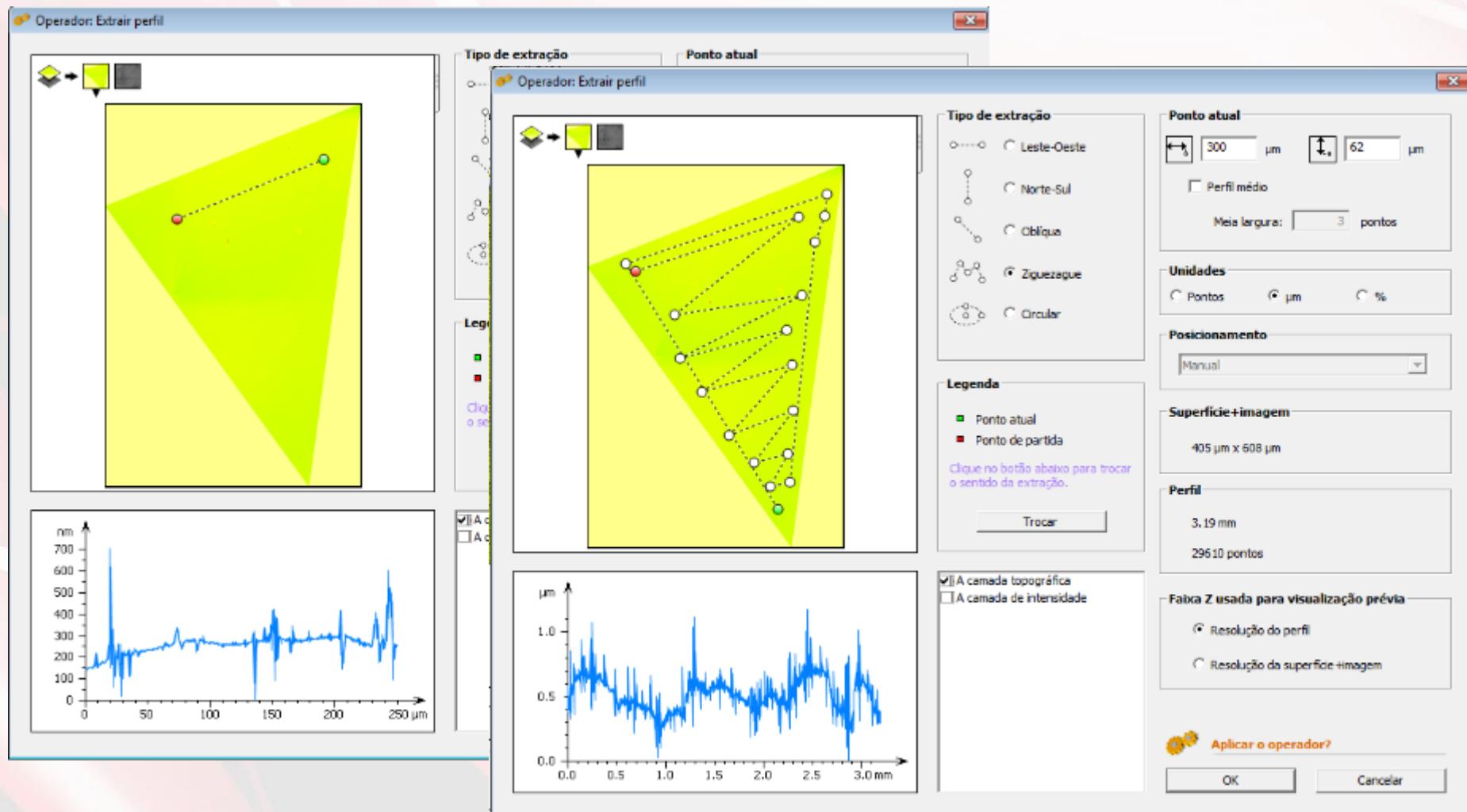


ISO 25178

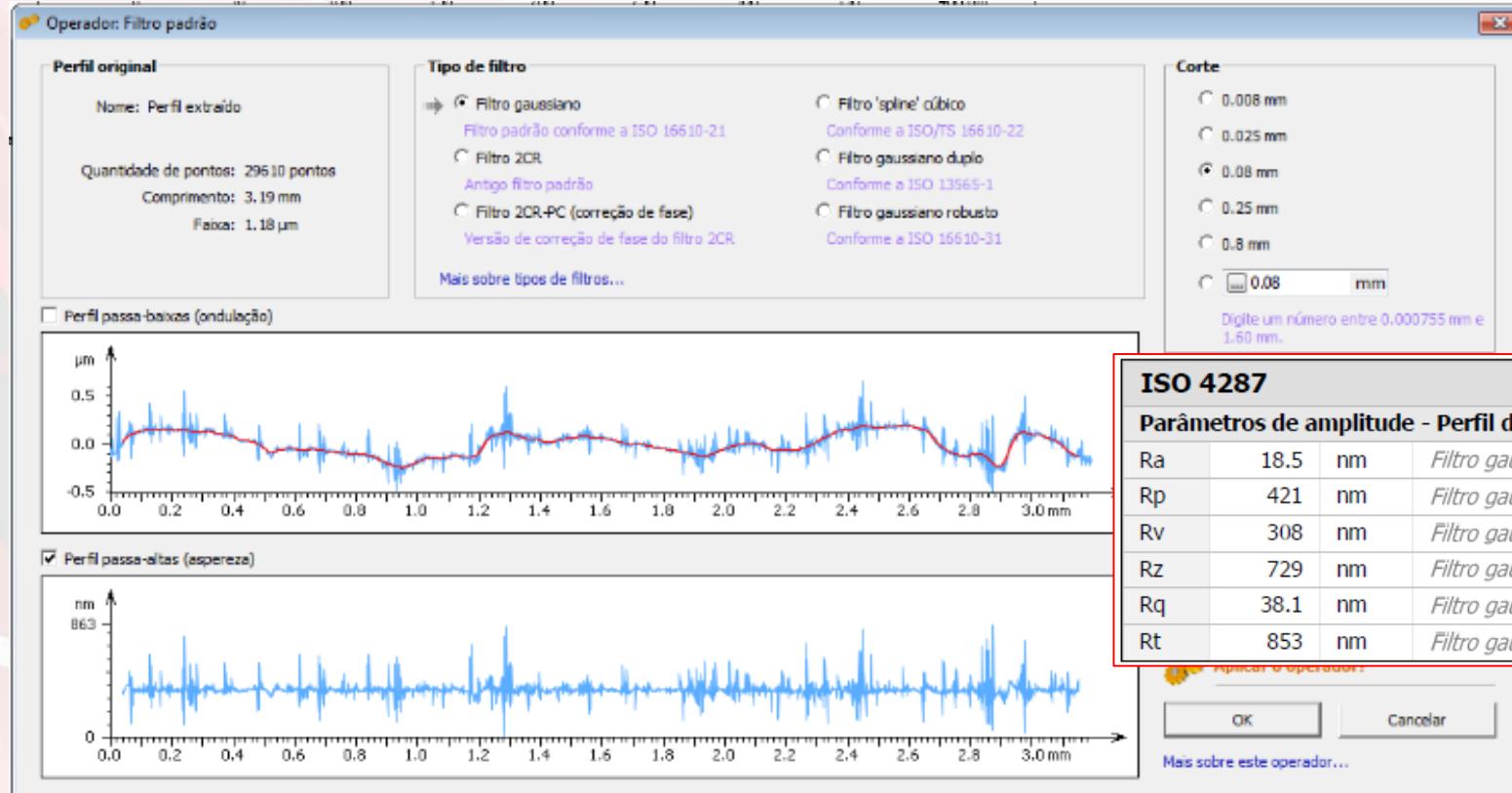
Parâmetros de altura

Sq	0.125	μm
Ssk	0.172	
Sku	15.9	
Sp	4.76	μm
Sv	5.42	μm
Sz	10.2	μm
Sa	0.101	μm

Avaliação da Rugosidade 3D e 2D



Avaliação da Rugosidade 3D e 2D



CM Explorer – Máq. Med. Óptica 3D

Accuracy^{1,2}

		Standard	Uncertainty, standard deviation
Measurement uncertainty by the example of step height measurement ^{2,3,4,5,6}	with objective lens 800 XS	Step = 75 µm	U = 0.320 µm, σ = 0.050 µm
		Step = 10 µm	U = 0.060 µm, σ = 0.020 µm
		Step = 1 µm	U = 0.030 µm, σ = 0.004 µm
Measurement uncertainty by the example of roughness measurement ^{2,3,4,5}	with objective lens 800 XS	Ra = 1.63 µm	U = 0.040 µm, σ = 0.004 µm
		Ra = 0.58 µm	U = 0.024 µm, σ = 0.0066 µm
		Ra = 0.23 µm	U = 0.010 µm, σ = 0.0050 µm
	with objective lens 320 S	Ra = 0.079 µm	U = 0.010 µm, σ = 0.0022 µm
	with objective lens 160 XS	Ra = 0.079 µm	U = 0.003 µm, σ = 0.0004 µm

L: long working distance
S: normal working distance
XS: short working distance

- 1) VIM 2012
- 2) with image acquisition module 1200x1200 with fine positioning unit
- 3) U according to ISO/IEC GUIDE 98- 3:2008(E), GUM:1995, K=1.96 (level of confidence 95%)
- 4) σ determined with 25 measurements
- 5) Measured in best possible conditions using PTB certified standards. Results only apply for the standards used.
- 6) Evaluation according to ISO 4287

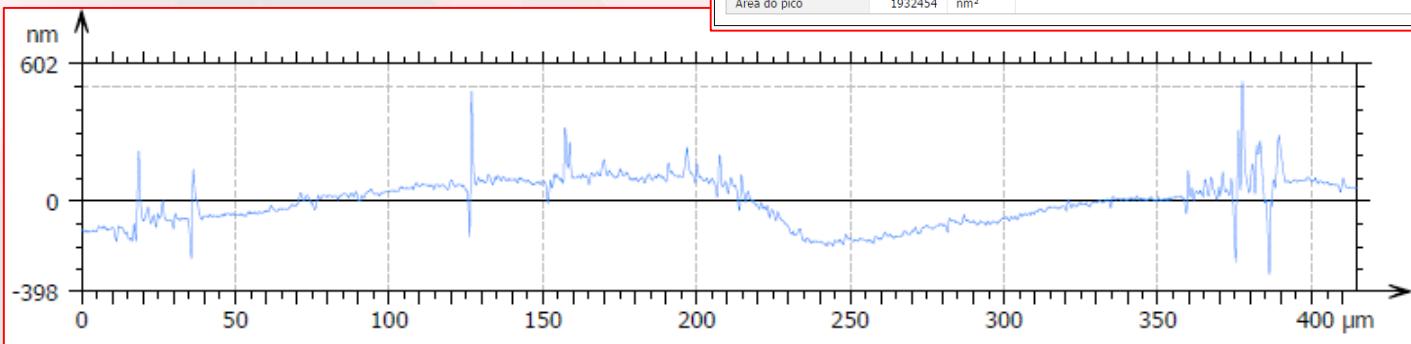
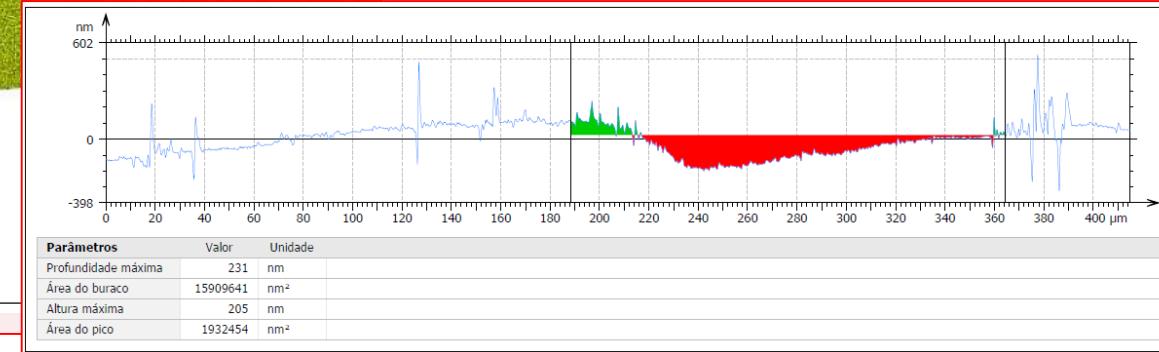
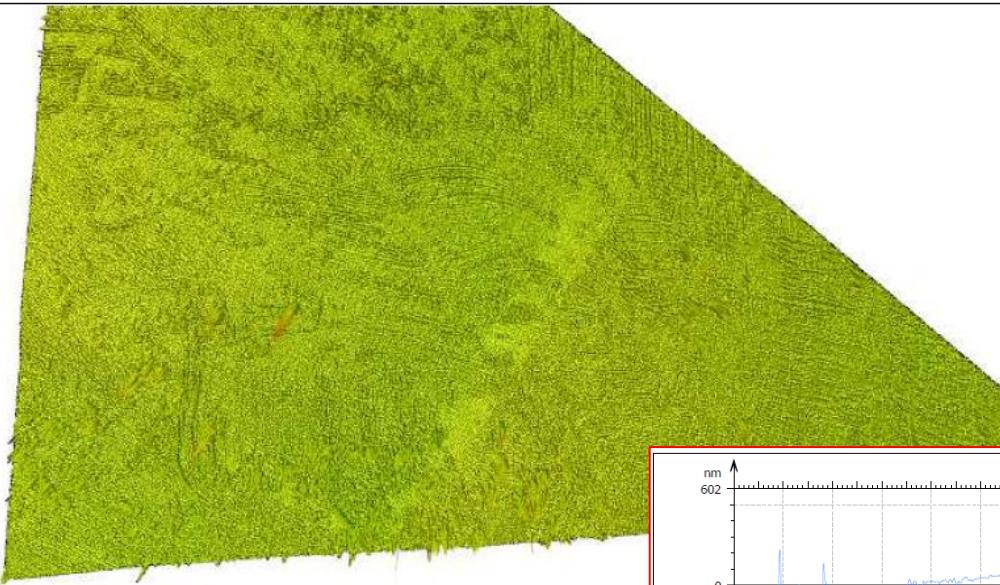
MarSurf



Para a aplicação apresentada, usamos:

CM Explorer com
Lente com ampliação de 50x
Resolução lente: 1200 x 1200 Mpx

CM Explorer – Máq. Med. Óptica 3D



Referências

- Kuzu, Cihan, et al. "Metrological Characterization of Hardness Indenter Calibration System." *Journal of Physics: Conference Series*, 2018, doi:10.1088/1742-6596/1065/6/062014.
- Norm, Deutsche. "Din En Iso 6507-1." *Metallic Materials*, 2004.
- Takagi, S., et al. "Verification of Vickers Indenter Geometry by Means of Three-Dimensional Coordinate Measurement." *Journal of Physics: Conference Series*, 2018, doi:10.1088/1742-6596/1065/6/062011.
- Takagi, Satoshi, et al. "Wide-Range Verification of the Geometry of Vickers Diamond Indenters." *18th IMEKO World Congress 2006: Metrology for a Sustainable Development*, 2006.

Agradecemos por sua participação!

Mahr do Brasil

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Ger. Produtos

Vinhedo – SP (Dez-2020)