

A Recent Look  
into Finishing Results  
of NZTE  
Mask Blank Substrates

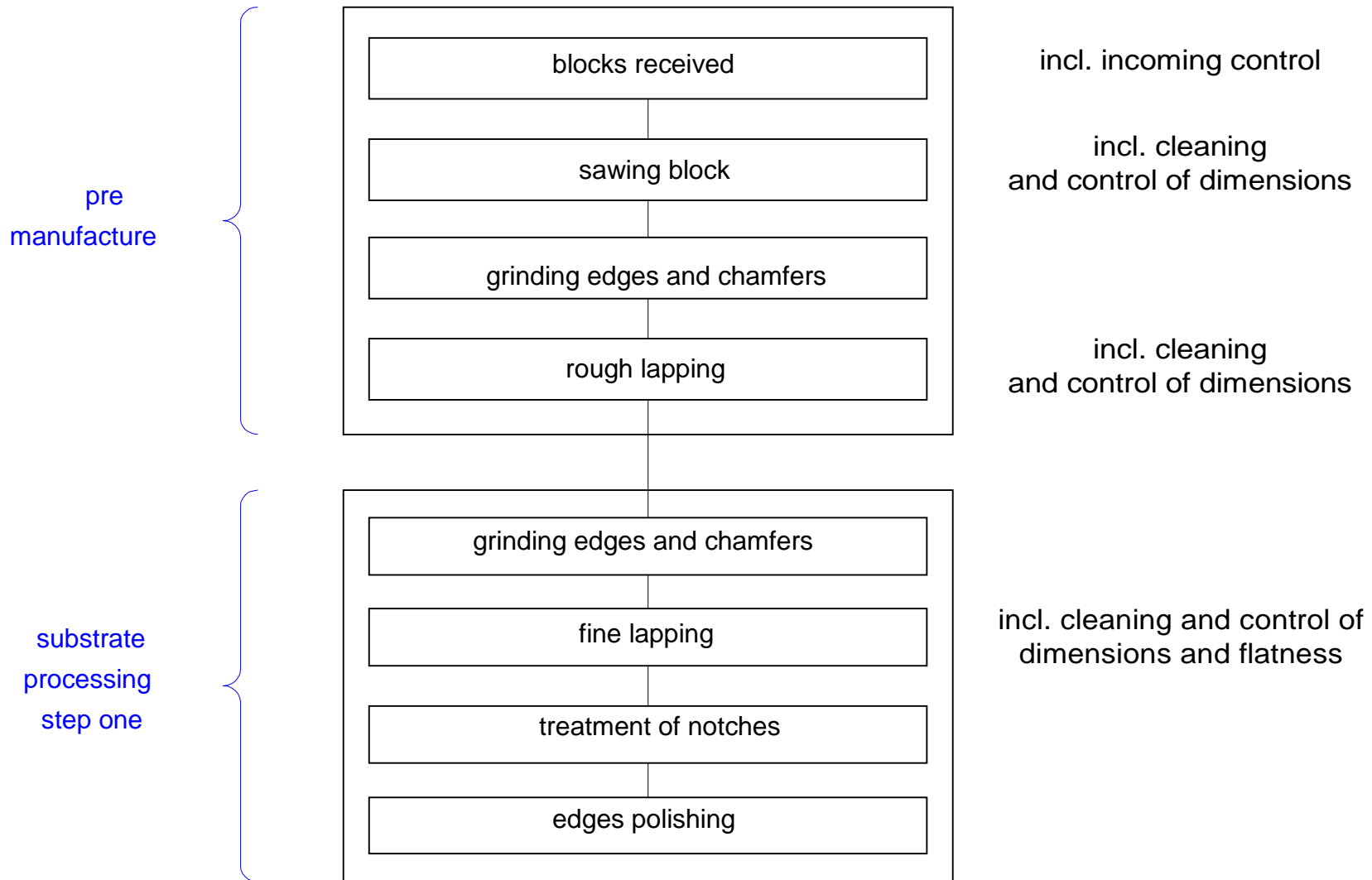
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## Summary:

- EUVL mask blank substrates (6025) made of NZTE materials are finished at Schott ML.
- The processes used for the EUVL mask blanks are compatible with the standard processes for fused silica substrates.
- Finishing processes giving improved flatness were introduced successfully.
- Issues related to NZTE materials are related mainly to defect density and size which may relate to material features.

# 1) First Steps in Substrate Processing:



After fine lapping:  $R_z = 0.8 \mu\text{m}$ ; Flatness:  $0.5 \dots 1.0 \mu\text{m}$ ; no scratches



## 2) Super Polishing:



- First polishing
- Brush cleaning
- Final polishing
- Cleaning
- Final cleaning
- IPA dry
- Laser scan

### 3) Flatness correction:

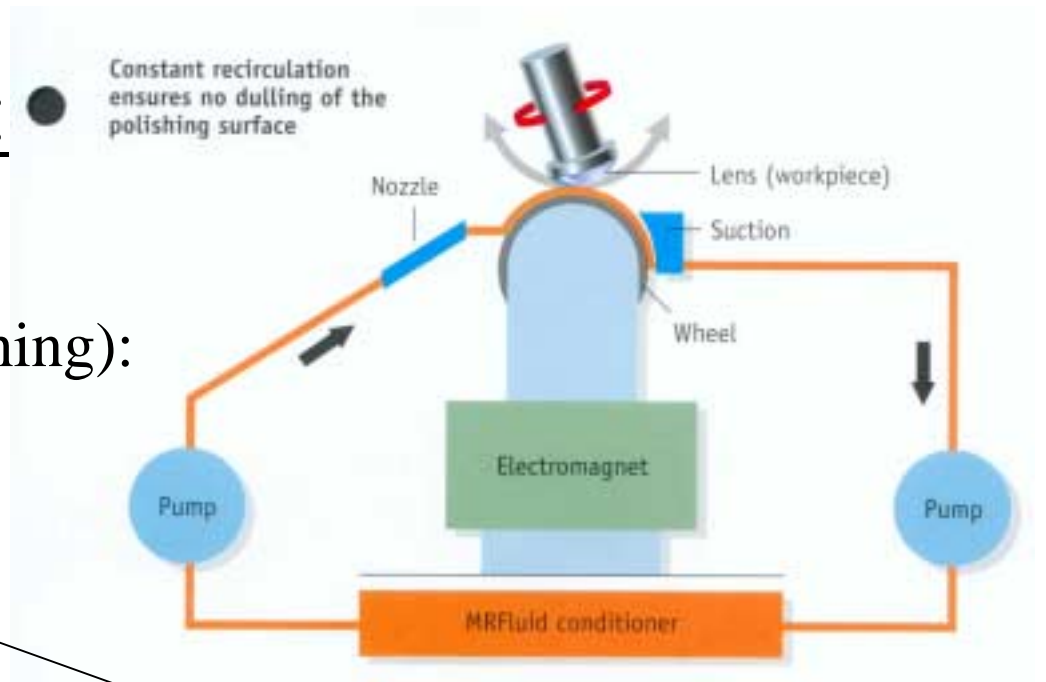
MRF (Magnetorheological Finishing):

or

IBF (Ion Beam Figuring):

or

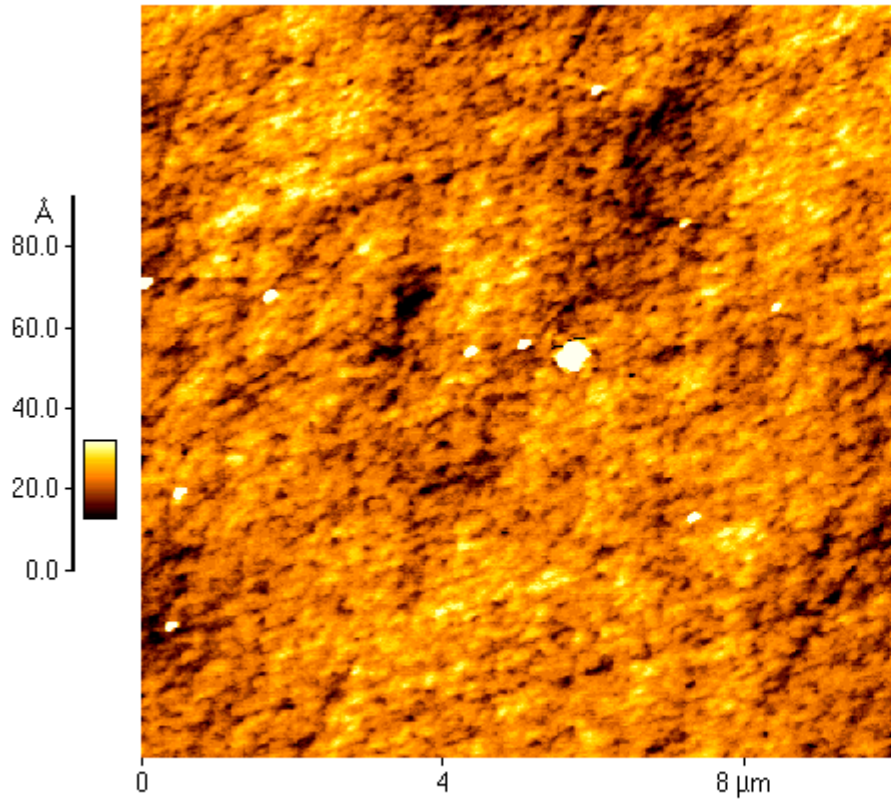
Single Side Polish:



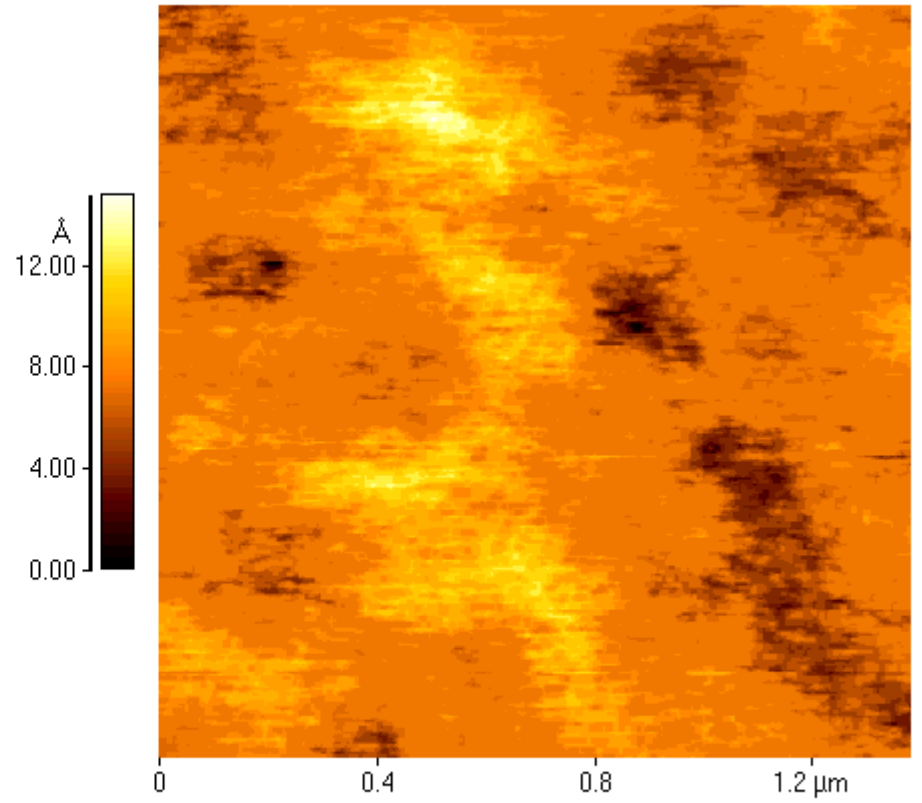
Maybe improvement of roughness by a 4<sup>th</sup> step?



# Roughness: **Zerodur** (after super polishing)

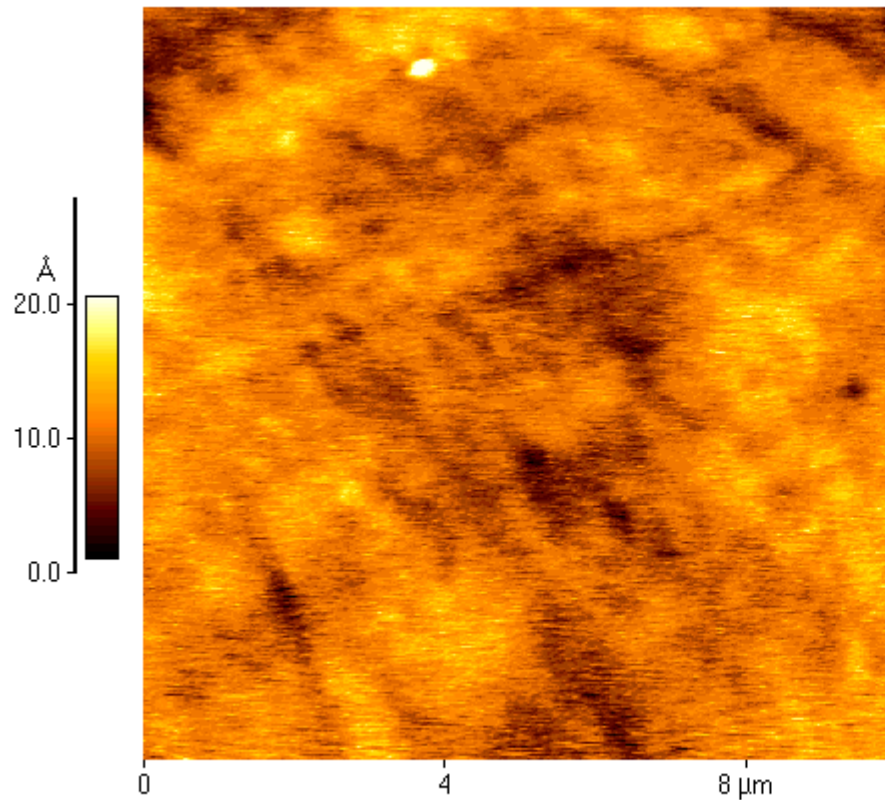


Ra=1,5Å, Rms=1,9Å, Rpv=12Å

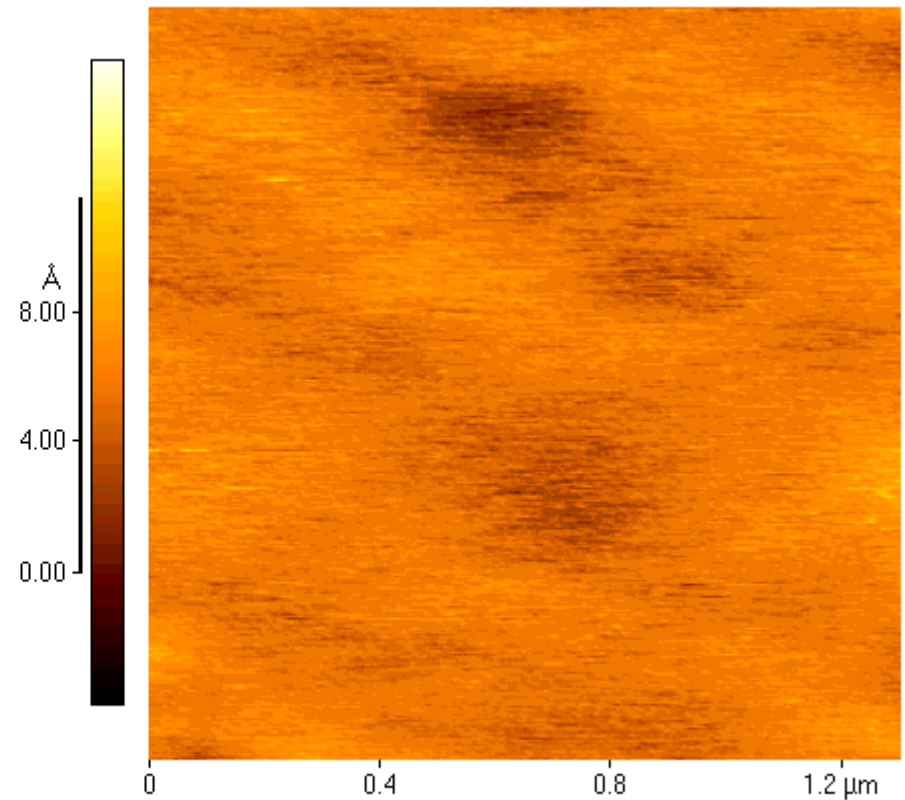


Ra=1,2Å, Rms=1,5Å, Rpv=7,1Å

# Roughness: **ULE** (after super polishing)

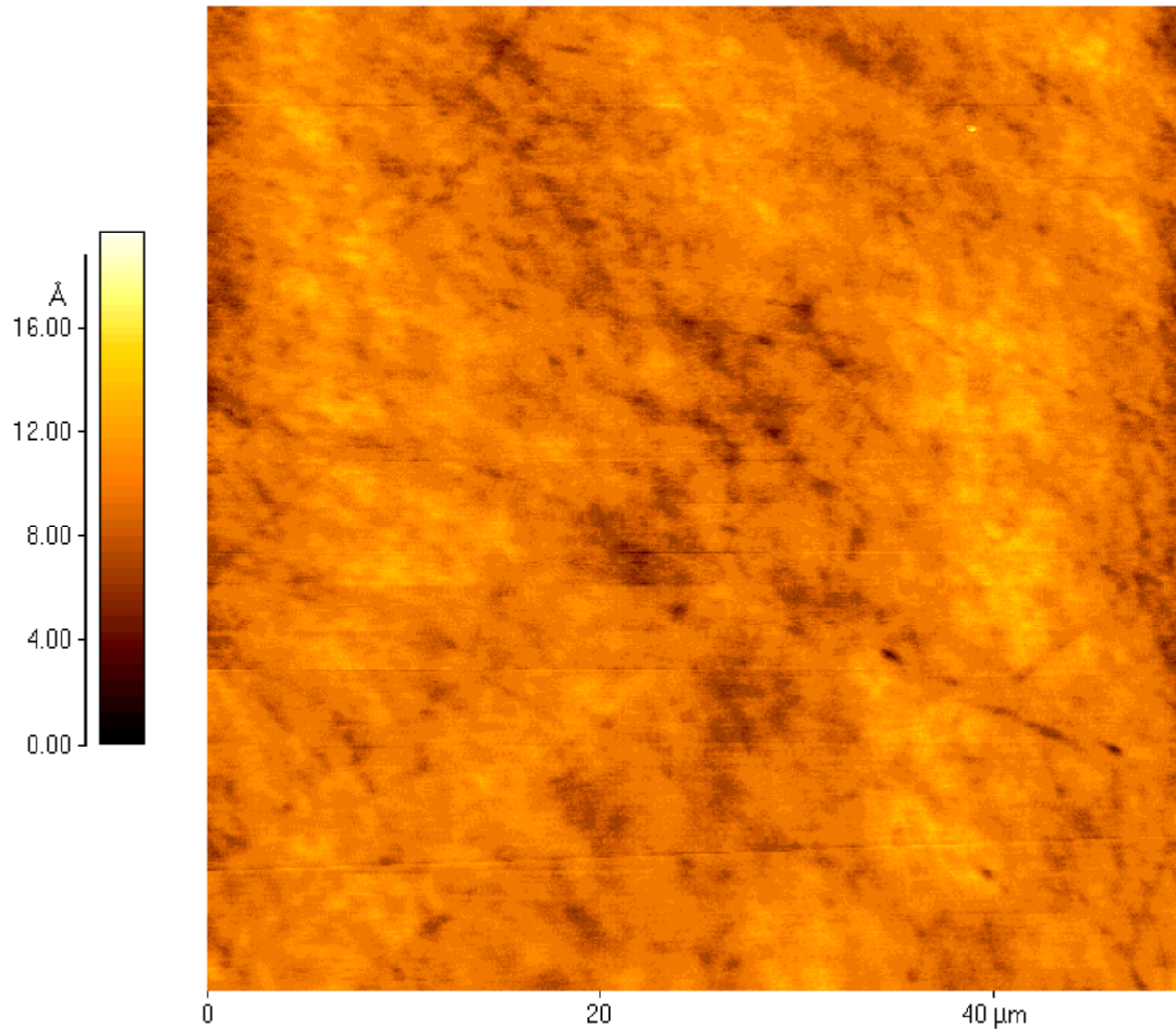


$R_a=0,98\text{\AA}$ ,  $R_{ms}=1,3\text{\AA}$ ,  $R_{pv}=8,9\text{\AA}$



$R_a=0,65\text{\AA}$ ,  $R_{ms}=0,91\text{\AA}$ ,  $R_{pv}=5,2\text{\AA}$

# Roughness: **Standard Quartz** (Rms 1.3 Å)



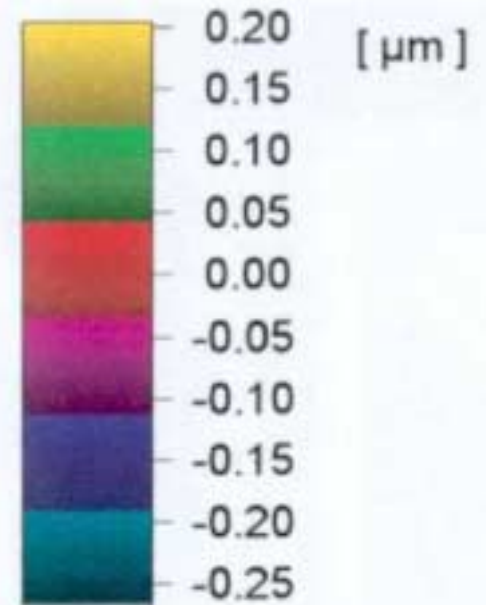
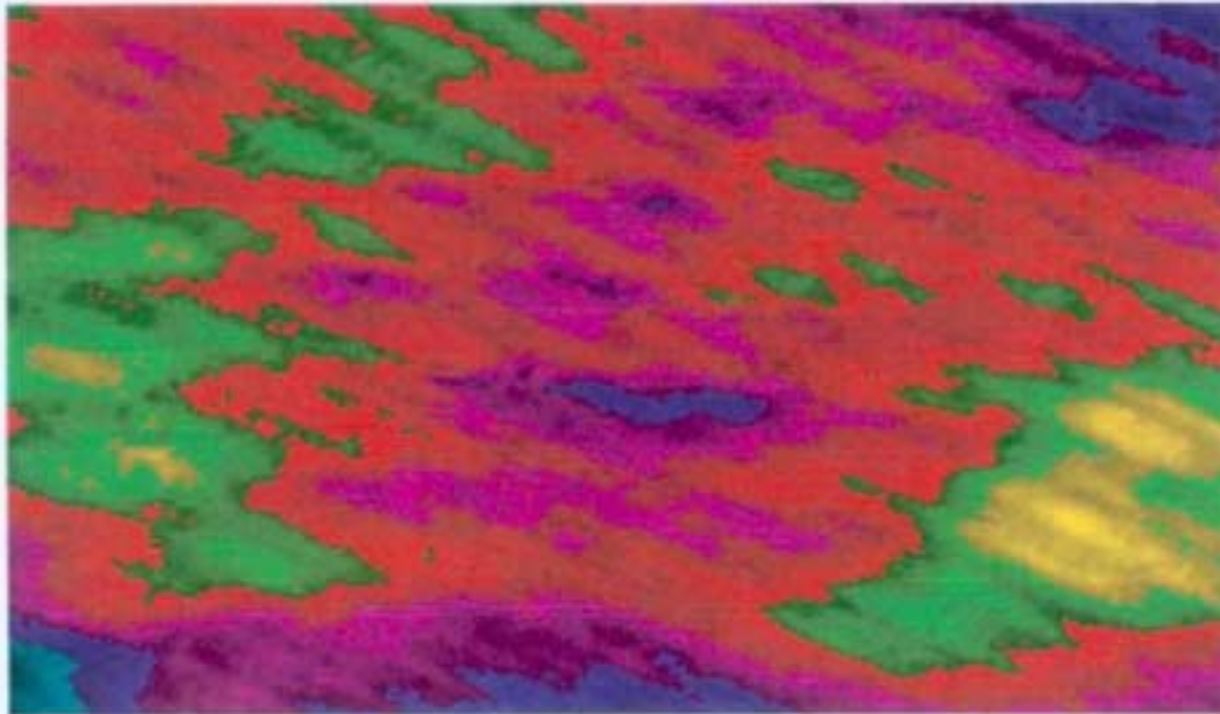
# Flatness

- Similar results for all materials (Zerodur, ULE, Standard Quartz)
- external measurements necessary: Process is better than the resolution of our interferometer.
- Flatness after Super Polishing: 0.18  $\mu\text{m}$
- Flatness obtained after MRF: 0.03  $\mu\text{m}$

# Flatness improvement

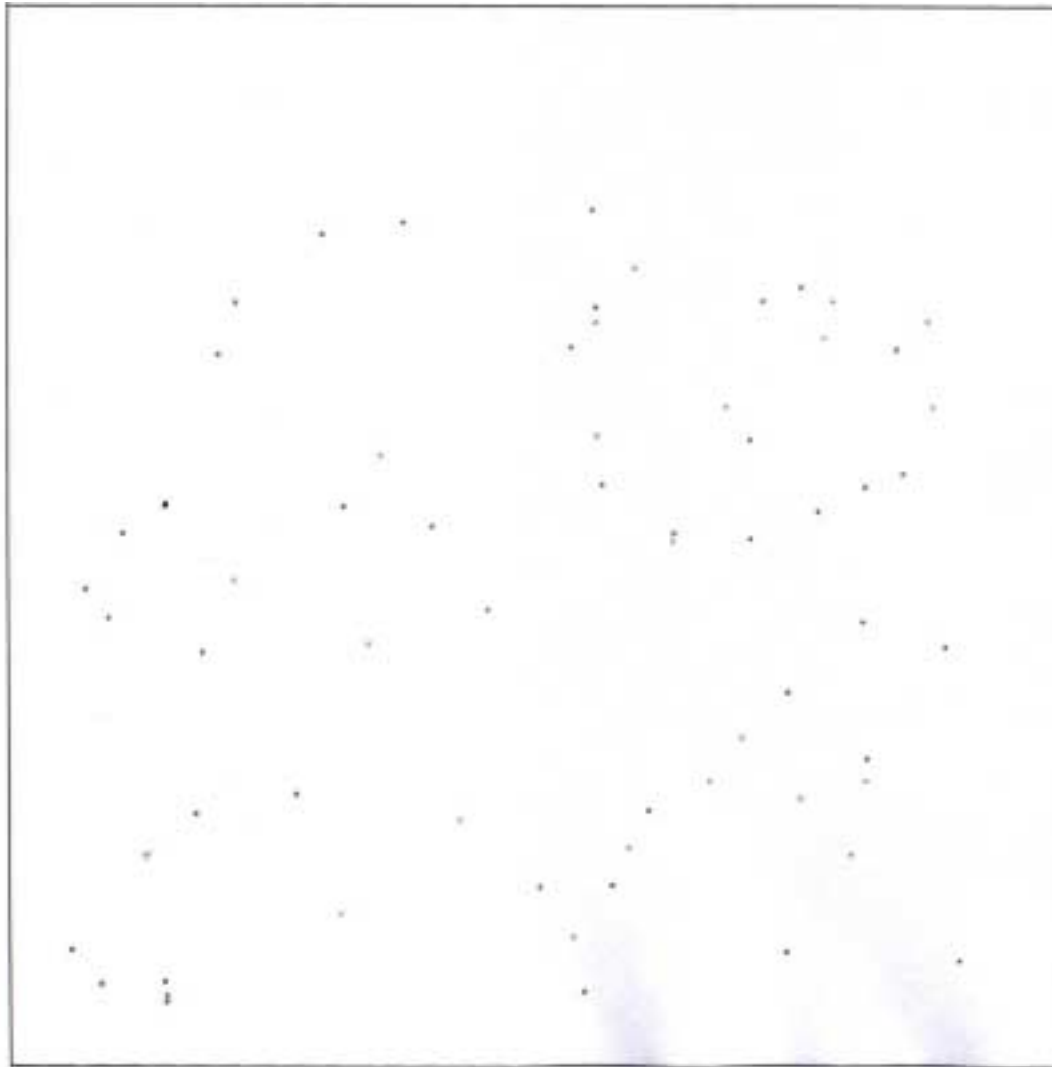
- EUVL mask blank substrate need improved flatness of 0.05  $\mu\text{m}$ .
- Standard substrate finishing does not support this requirement.
- IBF has the potential to produce better flatness than MRF.
- MRF is faster than IBF.
- MRF has been already applied to NZTE substrates.
- IBF treatment of Zerodur and ULE is currently investigated.

# Flatness: typical interferogram



P-V : 0.4736 [µm]  
RMS : 0.0705 [µm]

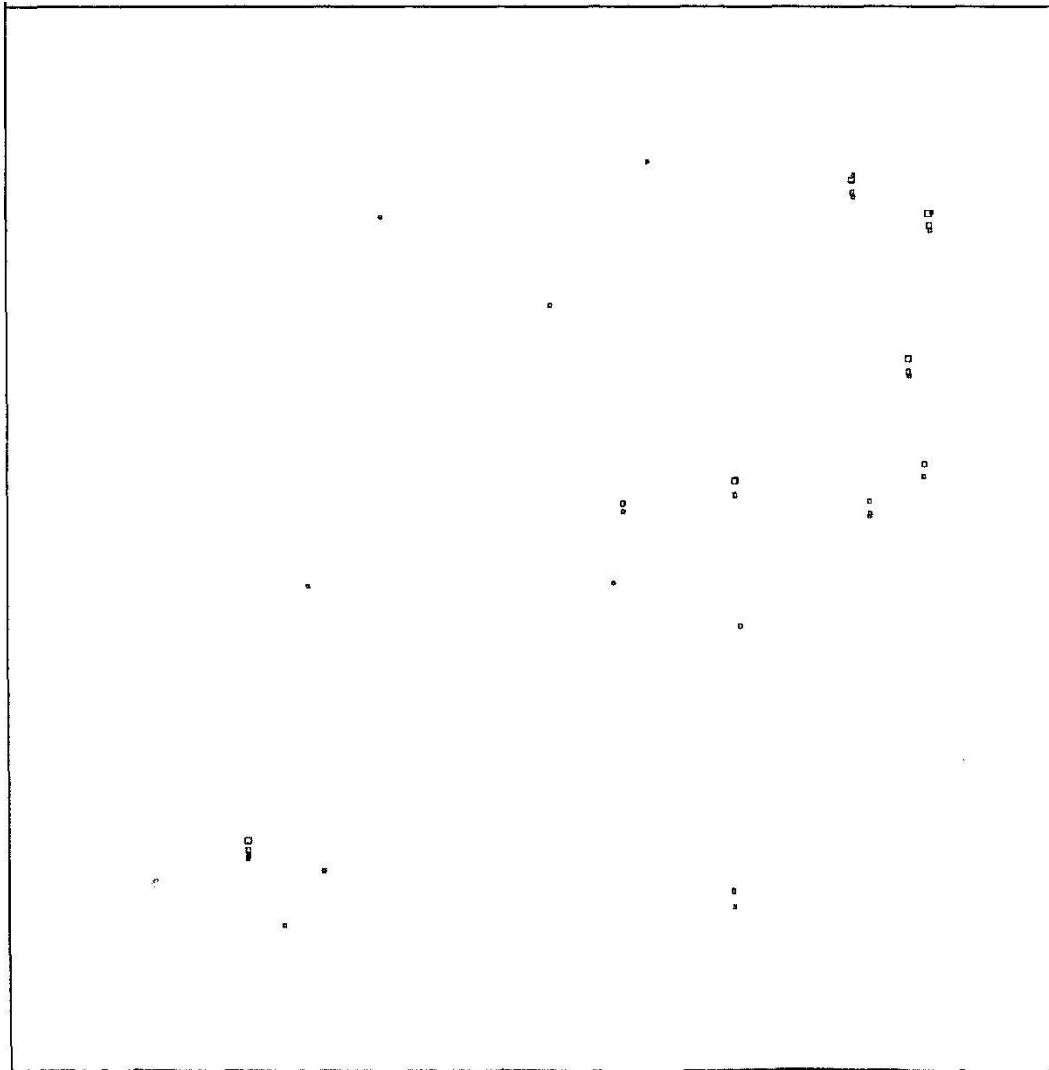
# Defects in Zerodur Substrates ( $\Rightarrow$ many small inclusions)



0								
50								
um	0.3	0.5	0.7	0.9	1.1	1.3	1.5	>1.5
n	0	0	0	0	0	0	0	0

44	Einschlüsse im Glas			
50				
um	0.6	1.0	1.5	>1.5
n	44	0	0	0

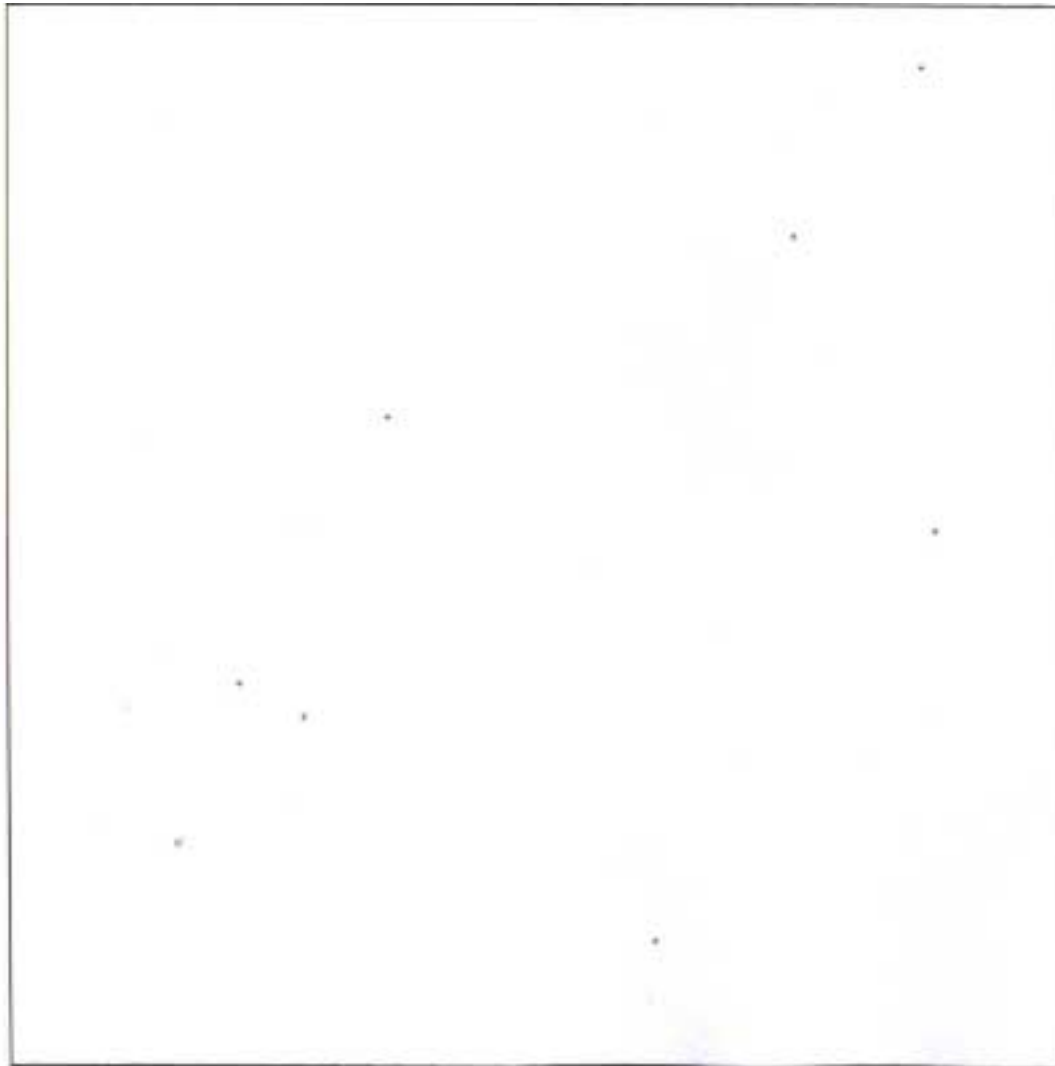
# Defects in ULE Substrates ( $\Rightarrow$ many large inclusions)



0								
50								
um	0.2	0.4	0.6	0.8	1.0	1.2	1.4	>1.4
n	0	0	0	0	0	0	0	0

34	Defekte Glassubstrat			
50				
um	0.2	0.5	1.0	>1.0
n	0	0	4	30

# Defects in **Standard Quartz** Substrates ( $\Rightarrow$ nearly no inclusions)



0								
50								
um	0.2	0.4	0.6	0.8	1.0	1.2	1.4	>1.4
n	0	0	0	0	0	0	0	0

7	Defekte Glassubstrat			
50				
um	0.2	0.5	1.0	>1.0
n	5	2	0	0