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Effect of Microtextured Regions on the Deformation Behavior of Titanium using FFT-EVP Simulations

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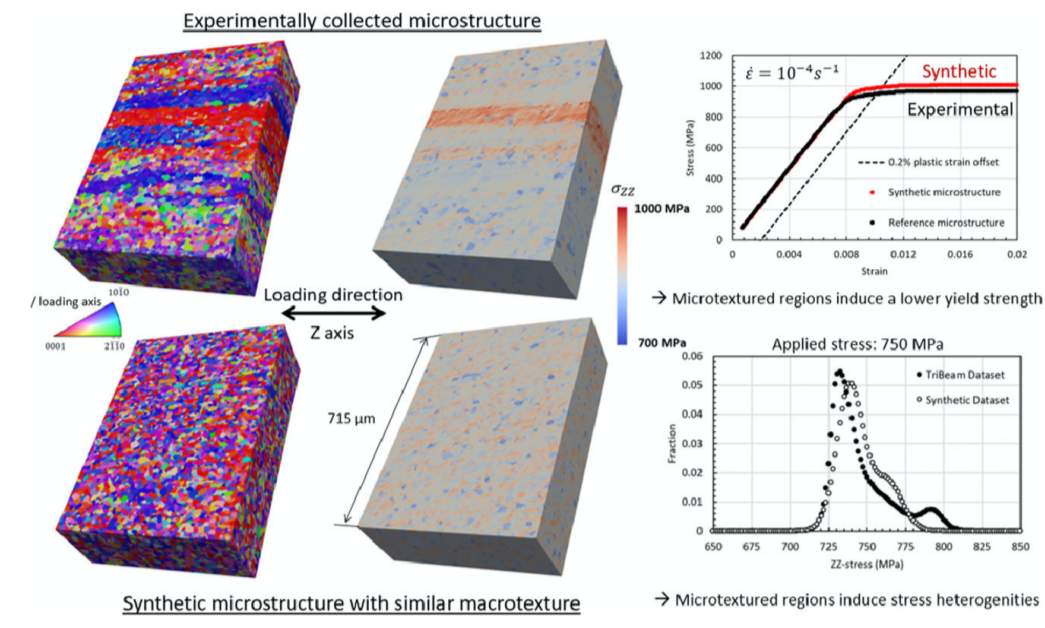
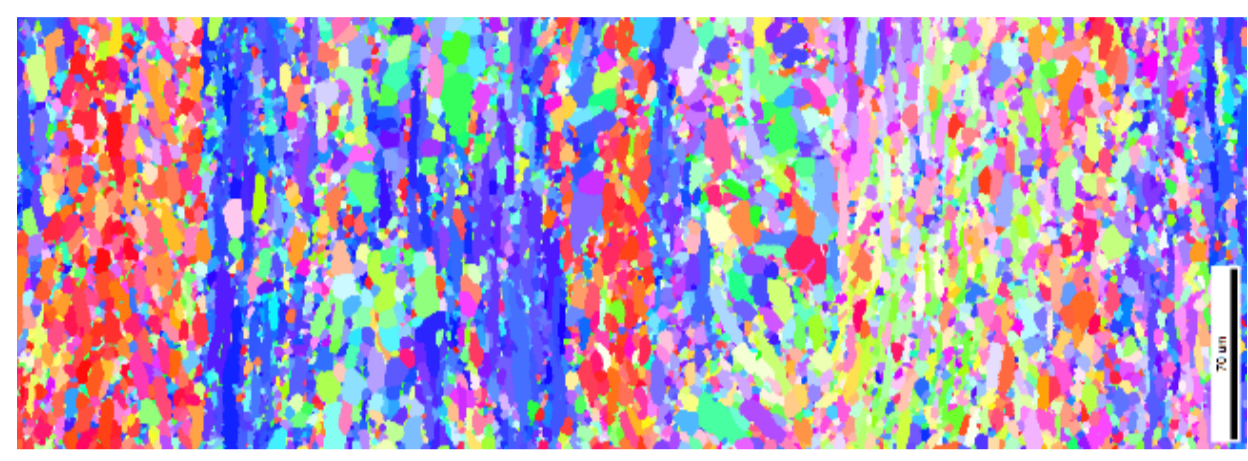
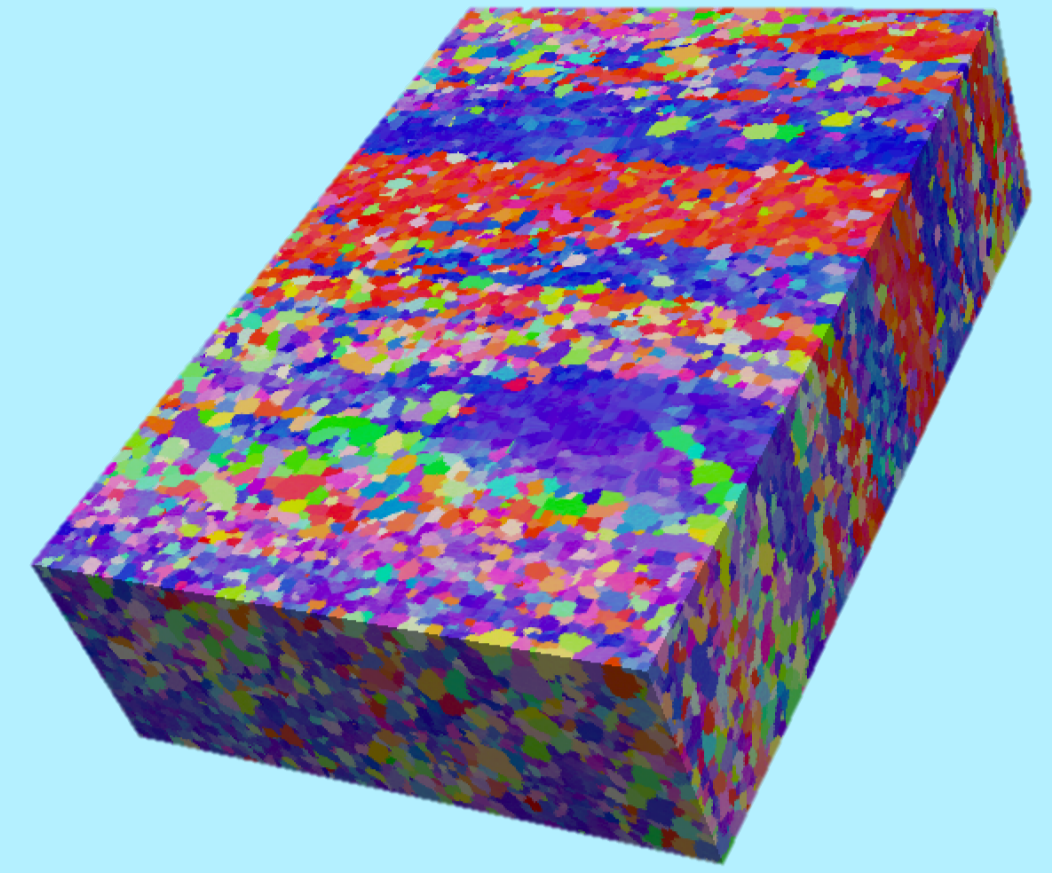
Contexte

- Generate 3D macro-zones while maintaining crystallographic texture and grain morphology.
- Study the influence of macro-zones on mechanical fields
- To study the influence of the morphology of the macro-zone on the macroscopic behavior.

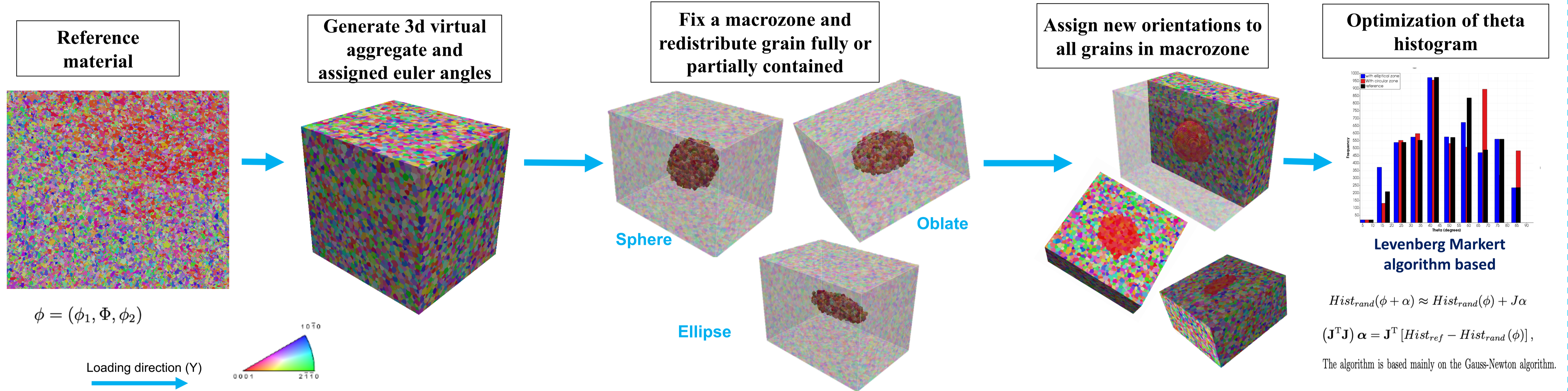
What is a Macrozone?

A Macrozone (or MTR) is a region with sharp texture...

Recent studies highlighted that the presence of micro-textured regions (MTRs), which result from the α/β processing step could have a major effect on the effective slip length.



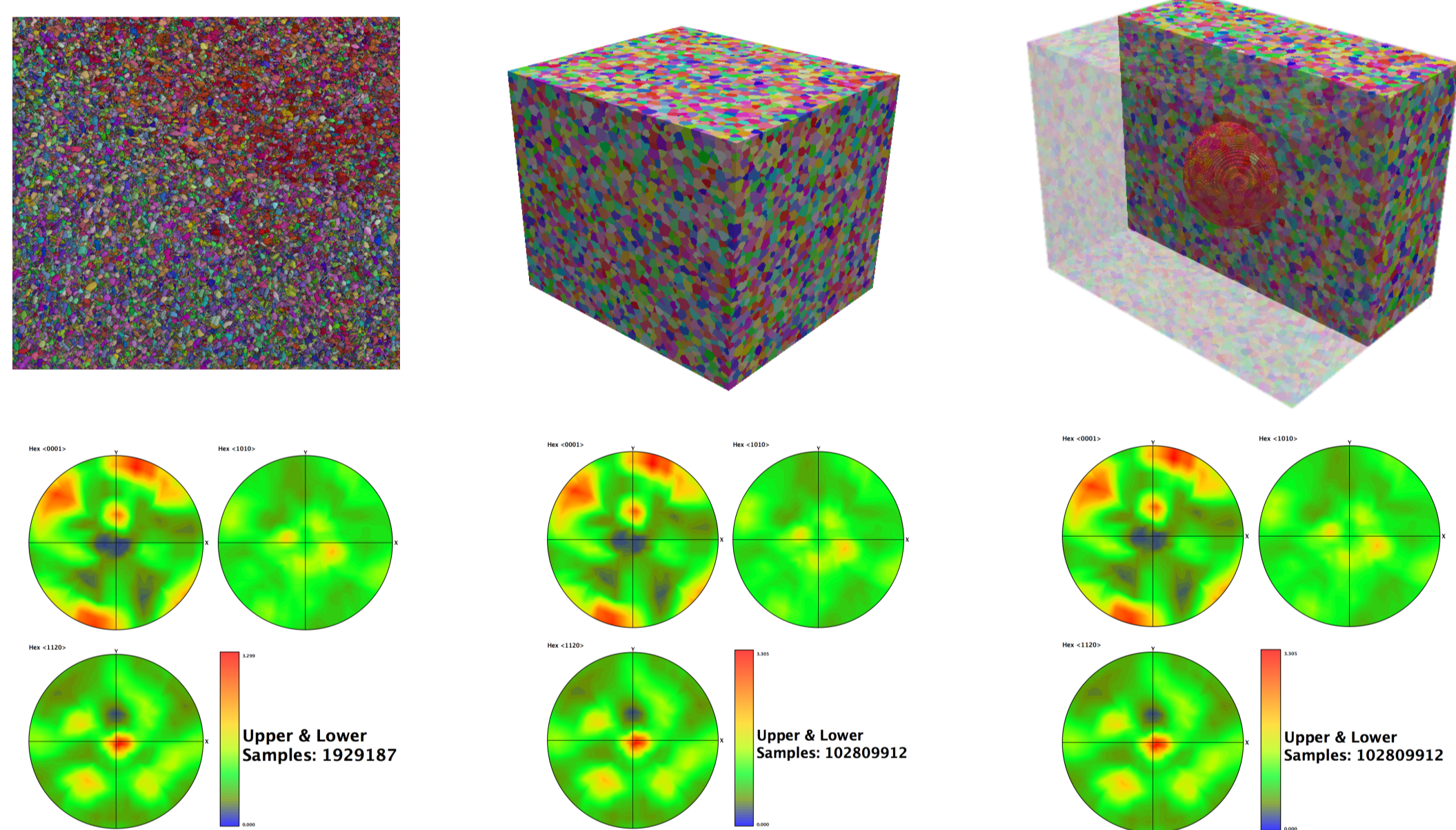
Macro-Zone generation



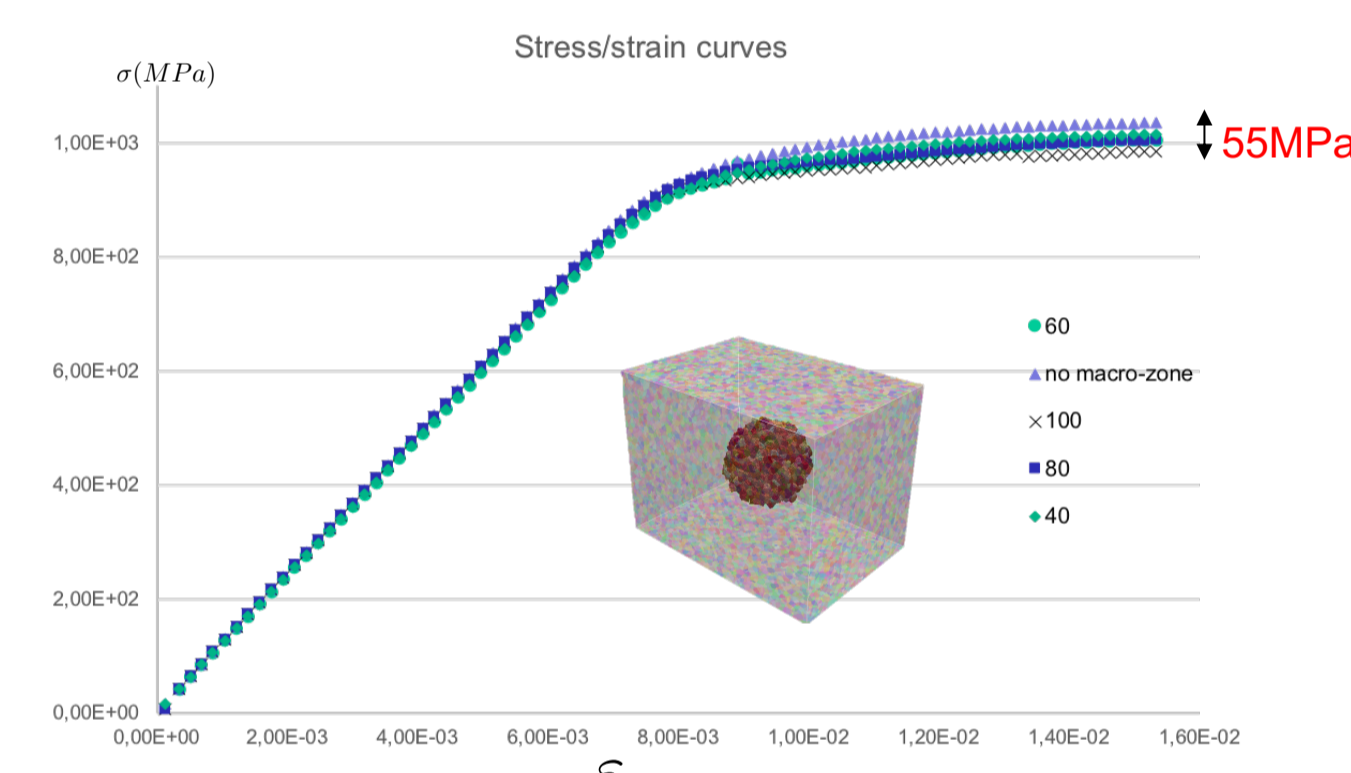
Macroscopic texture preserved

$\approx 1.4 \cdot 10^4$ grains

$\approx 8 \cdot 10^4$ grains
 $\approx 1.2 \cdot 10^8$ Voxels



FFT-EVP computation



- Crystal plasticity model

$$\dot{\epsilon}^p(x) = \sum_{s=1}^N m^s(x) \dot{\gamma}^s(x)$$

$$\dot{\gamma}^s(x) = \dot{\gamma}_0 \left(\frac{m^s(x) \sigma(x)}{\tau_0^s} \right)^n \text{sgn}(m^s(x) \cdot \sigma(x))$$

Elementary formulation
→ No fitted parameter
→ No hardening considered

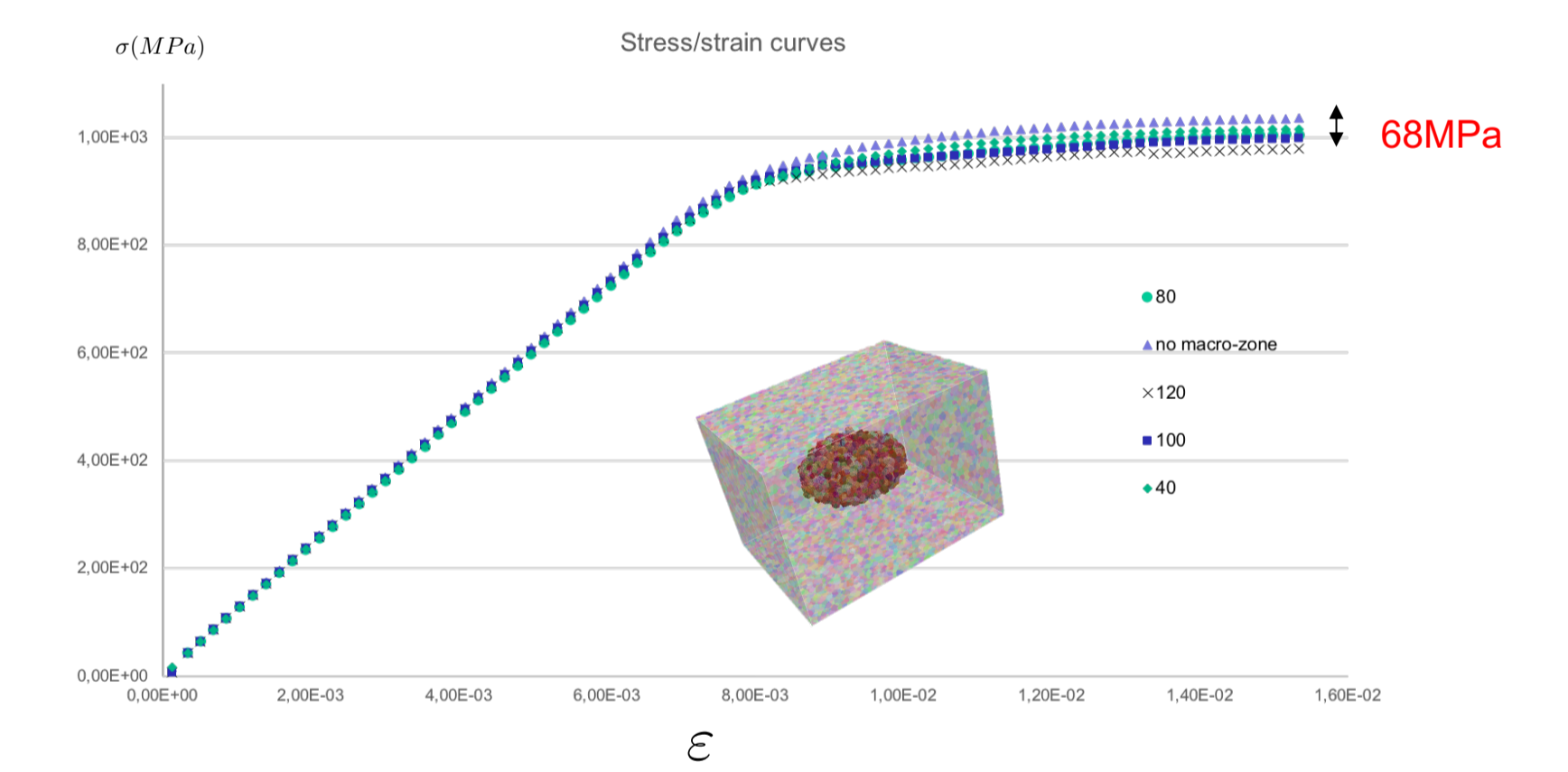
- Material parameters

Parameter	Value
Basal CRSS (τ_0^{Basal})	338 MPa
Prismatic CRSS ($\tau_0^{\text{Prismatic}}$)	352 MPa
Pyramidal CRSS ($\tau_0^{\text{Pyramidal}}$)	660 MPa
$\dot{\gamma}_0$	10^{-7} s^{-1}
n	0.02

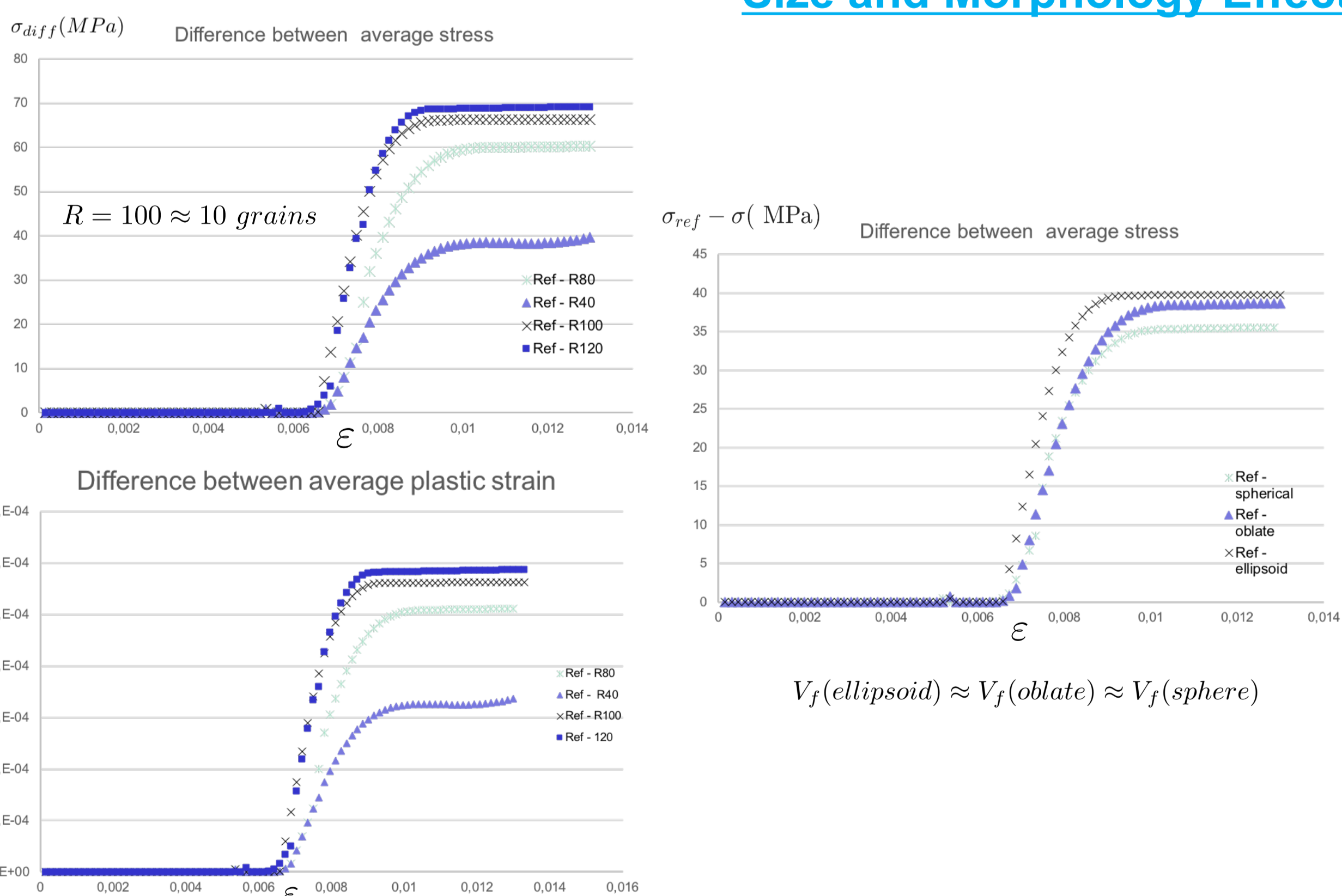
Material parameters extracted from literature data

• Elastic-viscoplastic - Fast Fourier Transforms based CP calculations

- In-house EVP-FFT code
- Computationally efficient calculations
- No meshing required
- Periodic boundary conditions



Size and Morphology Effects



Various harmful effects of MTR

- Size effects of the MTR on the
- Morphology effects

Effects on the macroscopic stress-strain behavior

Outlooks:

- Dwell / Fatigue effects?
- Comparison with self-consistent methods.
- Can we find a VER?

In summary

	Volum Fraction	500MPa		900MPa		RP02	
		σ_{max}	σ_{max}	ϵ_p	σ_{RP02}	σ_{max}	ϵ_p
No MTR	0%	602	1018	0.0078	996	1118	0.01
Sphere	0.5%	604	1022	0.0079	983	1140	0.0092
	3.6%	612	1036	0.0081	968	1227	0.0096
	7.0%	701	1186	0.009	953	1278	0.011
Oblate	0.3%	607	1027	0.0078	973	1202	0.0098
	1.0%	619	1048	0.0082	965	1216	0.0099
	1.9%	621	1052	0.0089	959	1256	0.0115
3.7%	662	1121	0.0094	951	1282	0.0116	
Ellipse	3.4%	675	1143	0.0087	932	1189	0.0115

Table of the different effects of the Morphology of MTR on stress and deformation

References

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