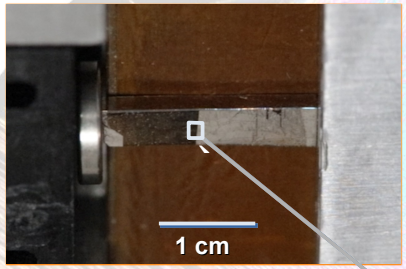
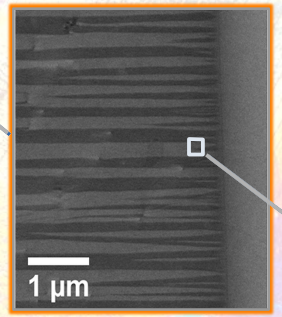
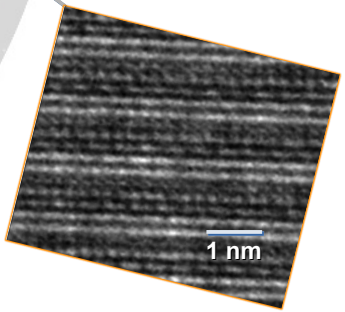
The magic of magnetic shape memory...

- Intro & Macrotwins
- *Movie with examples*
- Microtwins
- Nanotwins
- Summary





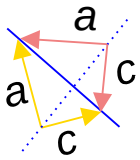


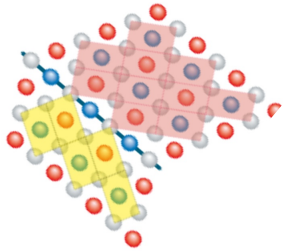
Twin microstructure

Tetragonal lattice : Enough to describe phenomenology

$a \approx b \approx 0.60$ nm
$c \approx 0.56$ nm
$\gamma \approx 90°$

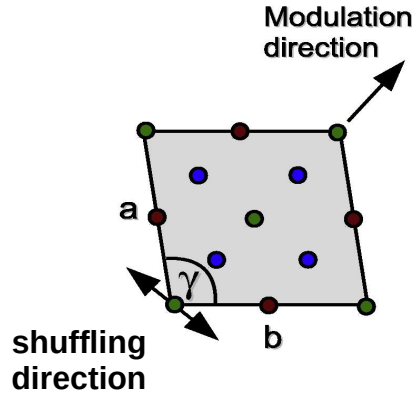
$c/a \approx 0.94$





In reality slightly monoclinic: Needed to describe mechanisms & microstructure

$a = 0.5969$ nm
$b = 0.5953$ nm
$c = 0.5615$ nm
$\gamma = 90.3°$



=> Other complex twinning in addition to *a/c* twins.

Straka, Ladislav, et al., Acta Materialia 59.20 (2011): 7450-7463.

Twin microstructure – 12 variants, 8 twinning systems, 5 different twin types

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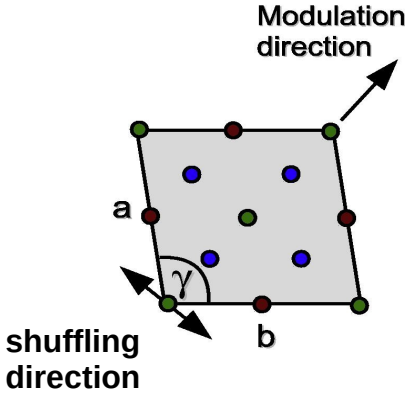

Variants	λ_2		n	$(F^{-1}b)/\lvert F^{-1}b \rvert$	Twinning type
1:2	1.0000	T_1	[0;1;0]	[1;0;0]	Modulation
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1:3	1.0000	T_1	$1/\sqrt{2}$[1;−1;0]	$1/\sqrt{2}$[1;1;0]	Compound
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1:4	1.0000	T_1	[−0.9509;0.3094;0]	[0.3094;0.9509;0]	Non-conventional[a]
		T_2	[0.3094;0.9509;0]	[0.9509;−0.3094;0]	Non-conventional[a]
1:5	1.0000	T_1	$1/\sqrt{2}$[0;1;−1]	[0.0682;0.7055;0.7055]	Type I
		T_2	[0.0779;0.7050;0.7050]	$1/\sqrt{2}$[0;−1;1]	Type II[b]
1:6	1.0000	T_1	[0.0779;0.7050;−0.7050]	$1/\sqrt{2}$[0;1;1]	Type II[b]
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1:12	1.0000	T_1	[0.7053;0.0721;−0.7053]	$1/\sqrt{2}$[1;0;1]	Type II[c]
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landscape around *a/c* twins – various interactions with a/c twins

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Straka, Ladislav, et al., Acta Materialia 59.20 (2011): 7450-7463.

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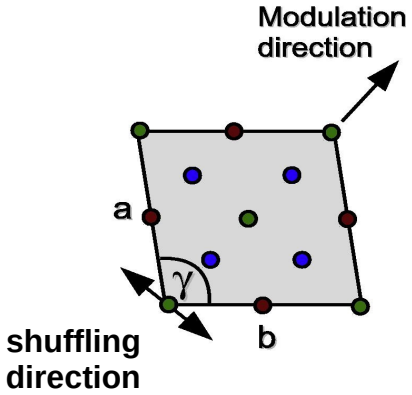
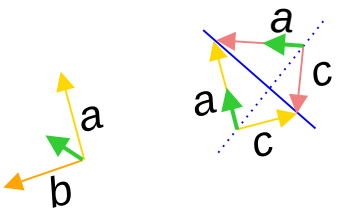
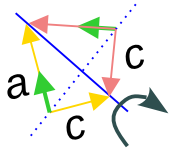


Type I twin - reflection



Type II twin – 180° rotation



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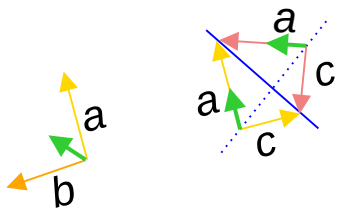

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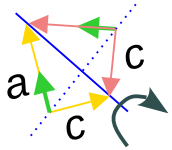

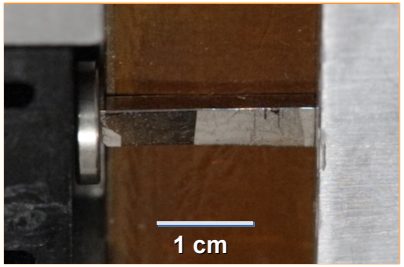

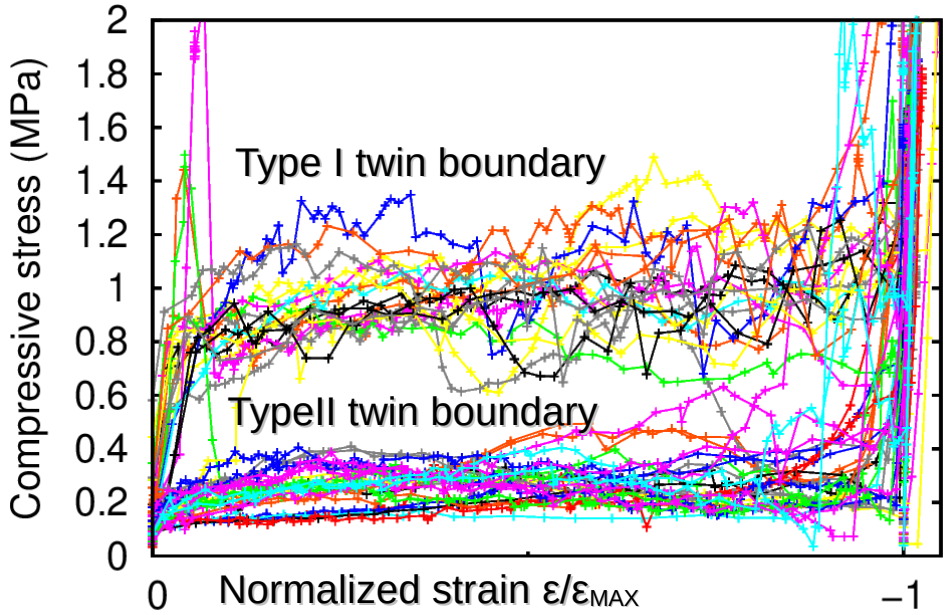

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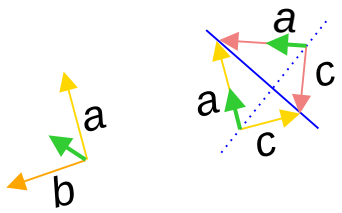

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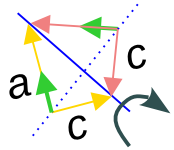

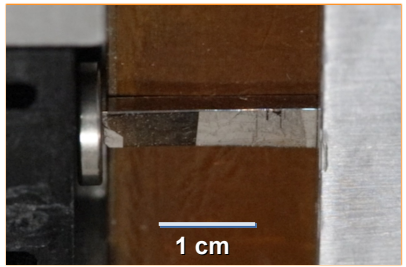

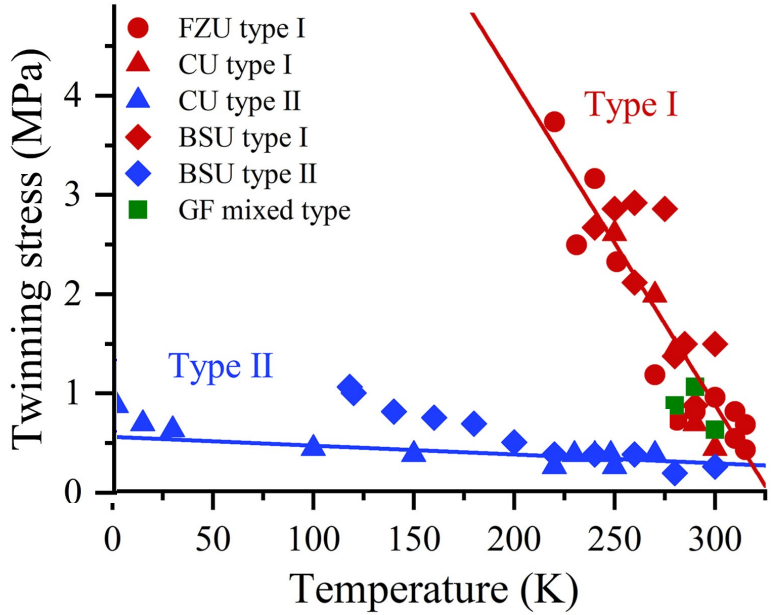

Musiienko, Denys, et al. J. Materials Research and Technology 14 (2021): 1934-1944.

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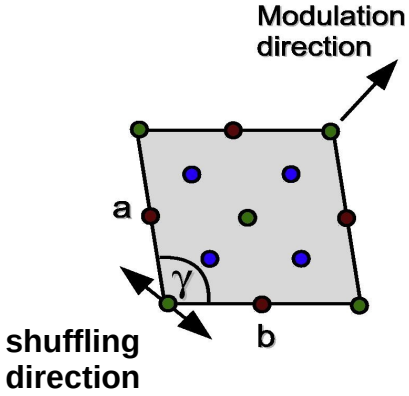

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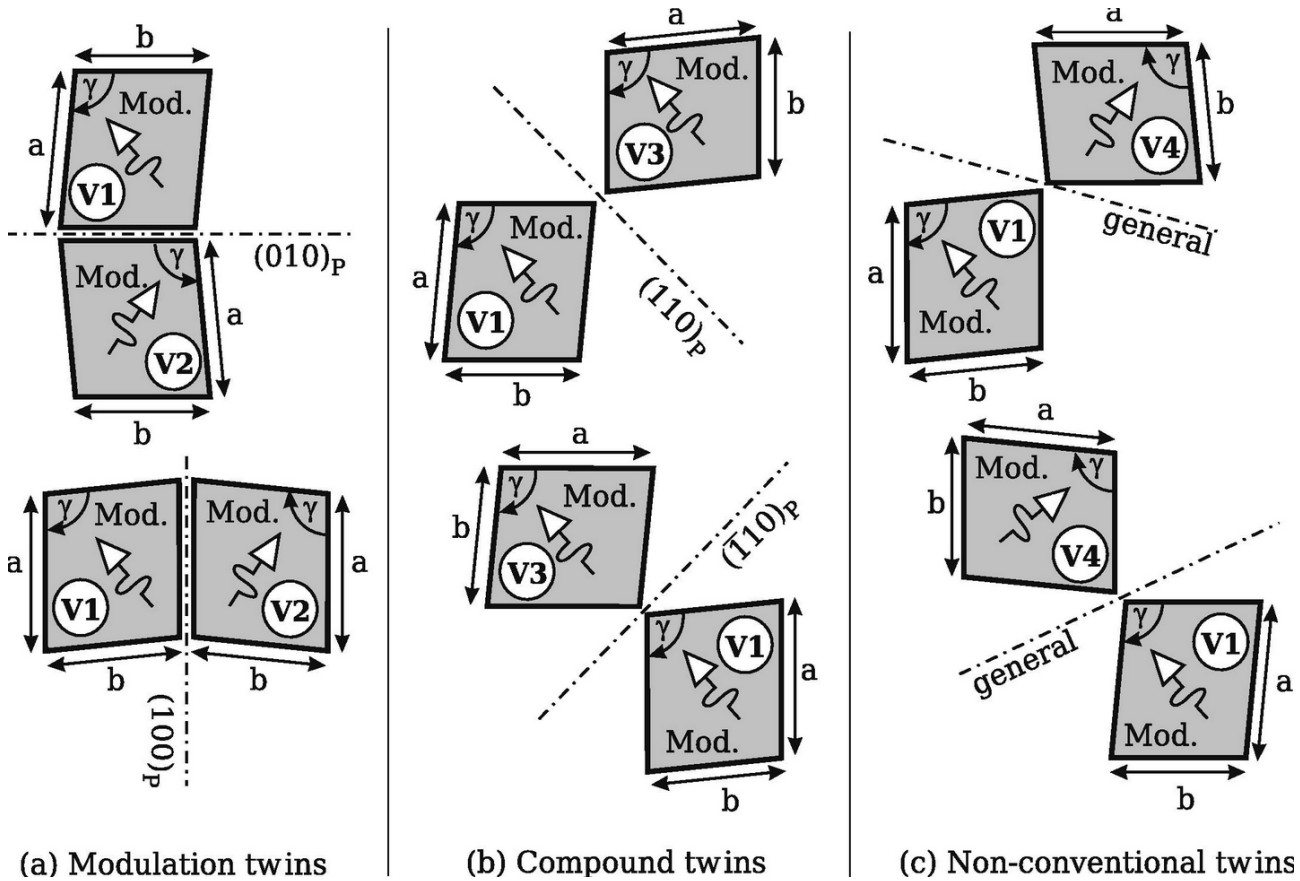
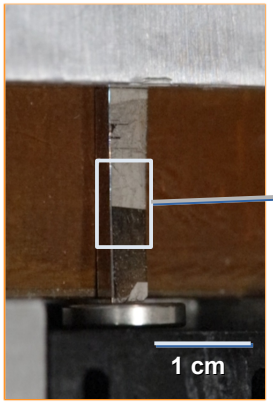
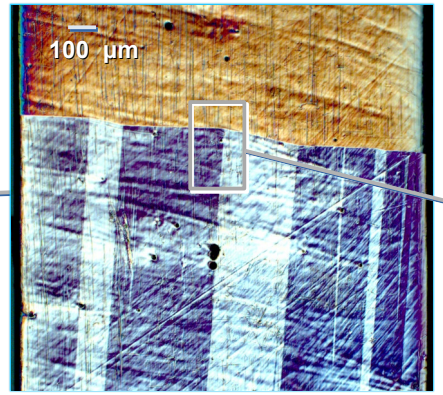


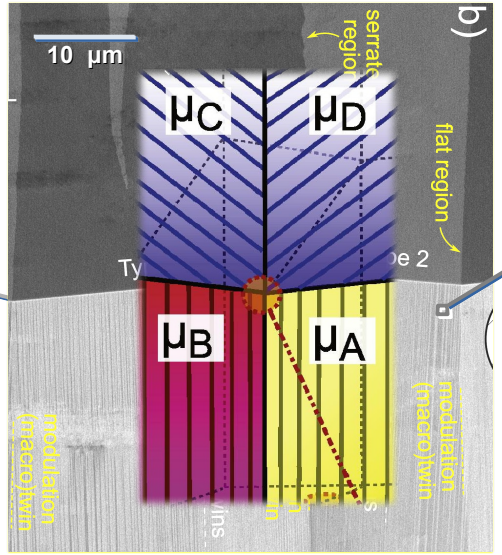
Straka, Ladislav, et al., Acta Materialia 59.20 (2011): 7450-7463.

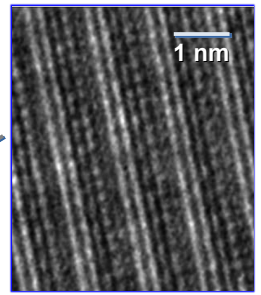
Martensite with deep twinning hierarchy

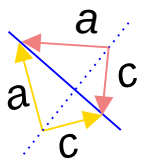
cm mm 100 µm 10µm SCALE 1µm 100 nm 10 nm 1 nm



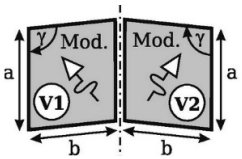




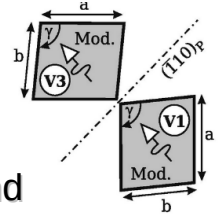




a/c twins
(101) Type I, Type II



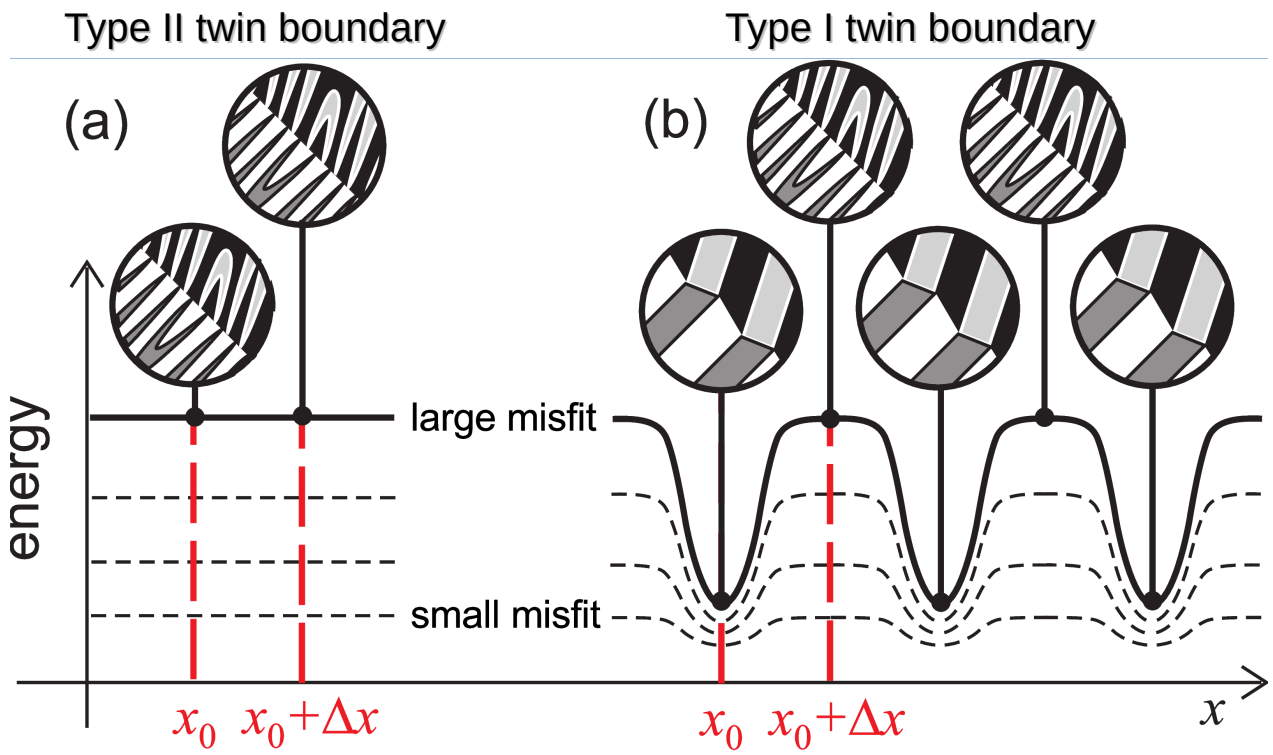
Monoclinic (modulation) twins
(100) compound



a/b twins
(110) compound

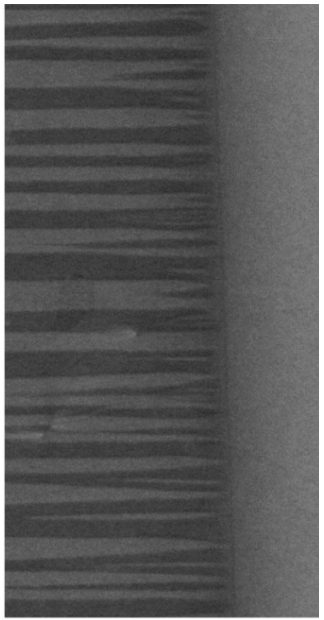
a/b nanotwins +
structural twins

Martensite with deep twinning hierarchy

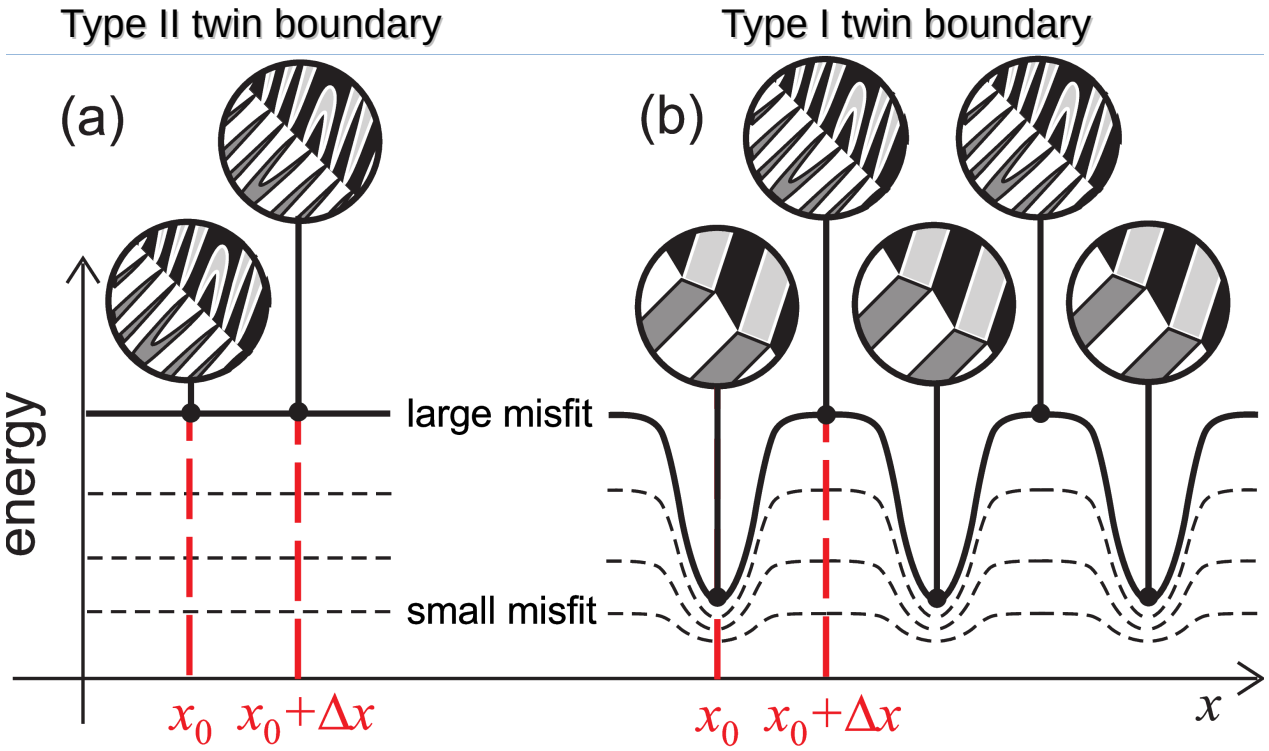


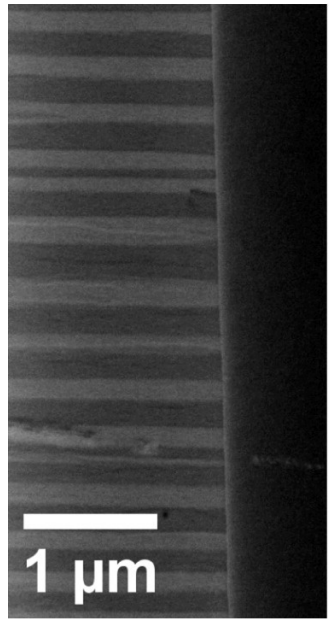
Seiner, Hanuš, Ladislav Straka, and Oleg Heczko, J. Mechanics and Physics of Solids 64 (2014): 198-211.

Microstructural model of Type I/Type II twin boundary propagation



Type II

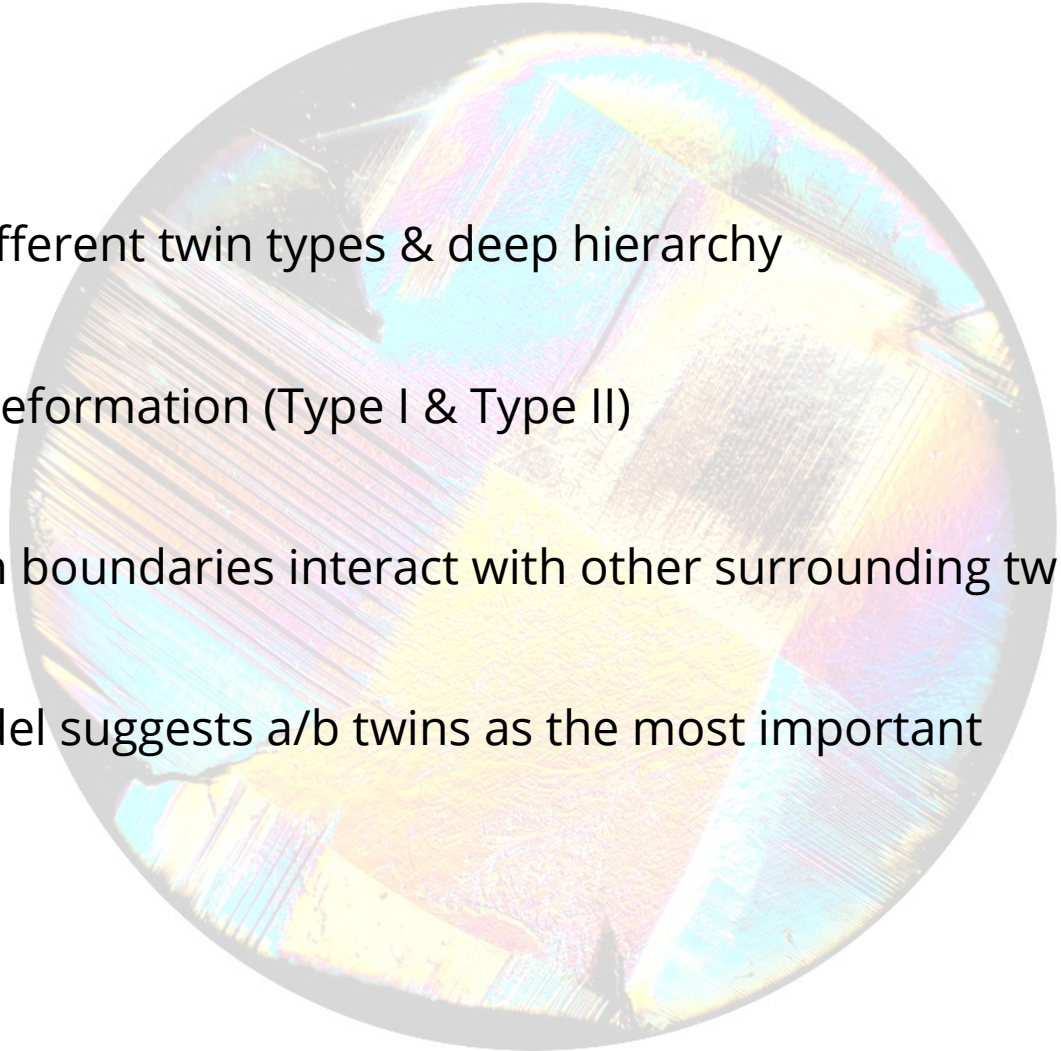




Type I

Seiner, Hanuš, Ladislav Straka, and Oleg Heczko, J. Mechanics and Physics of Solids 64 (2014): 198-211.
Heczko, Oleg, Ladislav Klimša, and Jaromír Kopeček, Scripta Materialia 131 (2017): 76-79.

Summary III



- Martensite with 5 different twin types & deep hierarchy
- a/c twins carry the deformation (Type I & Type II)
- Propagating a/c twin boundaries interact with other surrounding twins
- Microstructural model suggests a/b twins as the most important