Introduction to Rotary NiTi Instruments

The University of Western Australia, School of Dentistry

Dr Mostafa Elkholy, BDS, MSc, Phd

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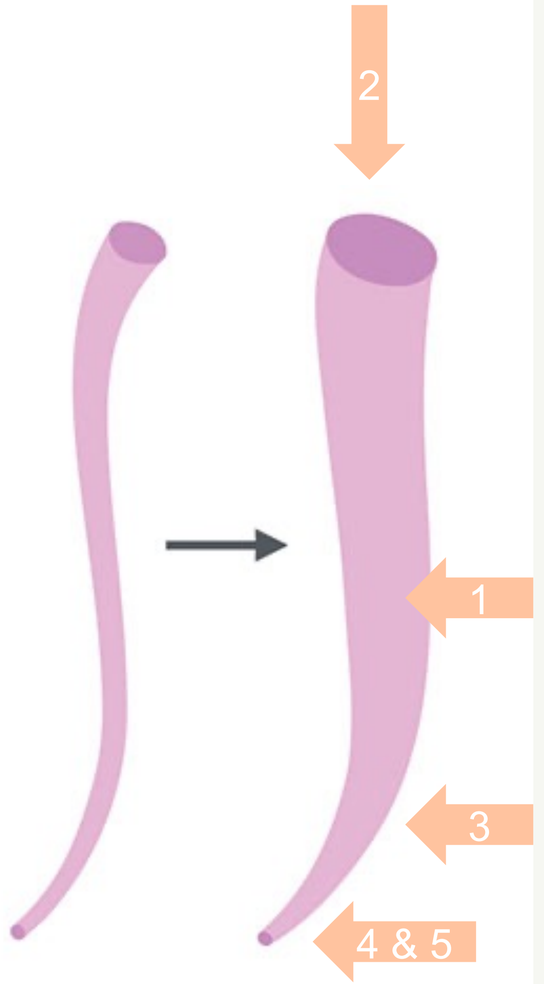
Mechanical Objectives

1. Continuously tapering funnel from the apex to the access cavity.
2. Cross-sectional diameter should be narrower at every point apically.
3. The root canal preparation should flow with the shape of the original canal.
4. The apical foramen should remain in its original position.
5. The apical opening should be kept as small as practical.



Schilder,1974

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Biological Objectives

1. Confinement of instrumentation to the roots themselves.
2. No forcing of necrotic debris beyond the foramen.
3. Removal of all tissue from the root canal space.
4. Creation of sufficient space for intra-canal medicaments..

Schilder,1974

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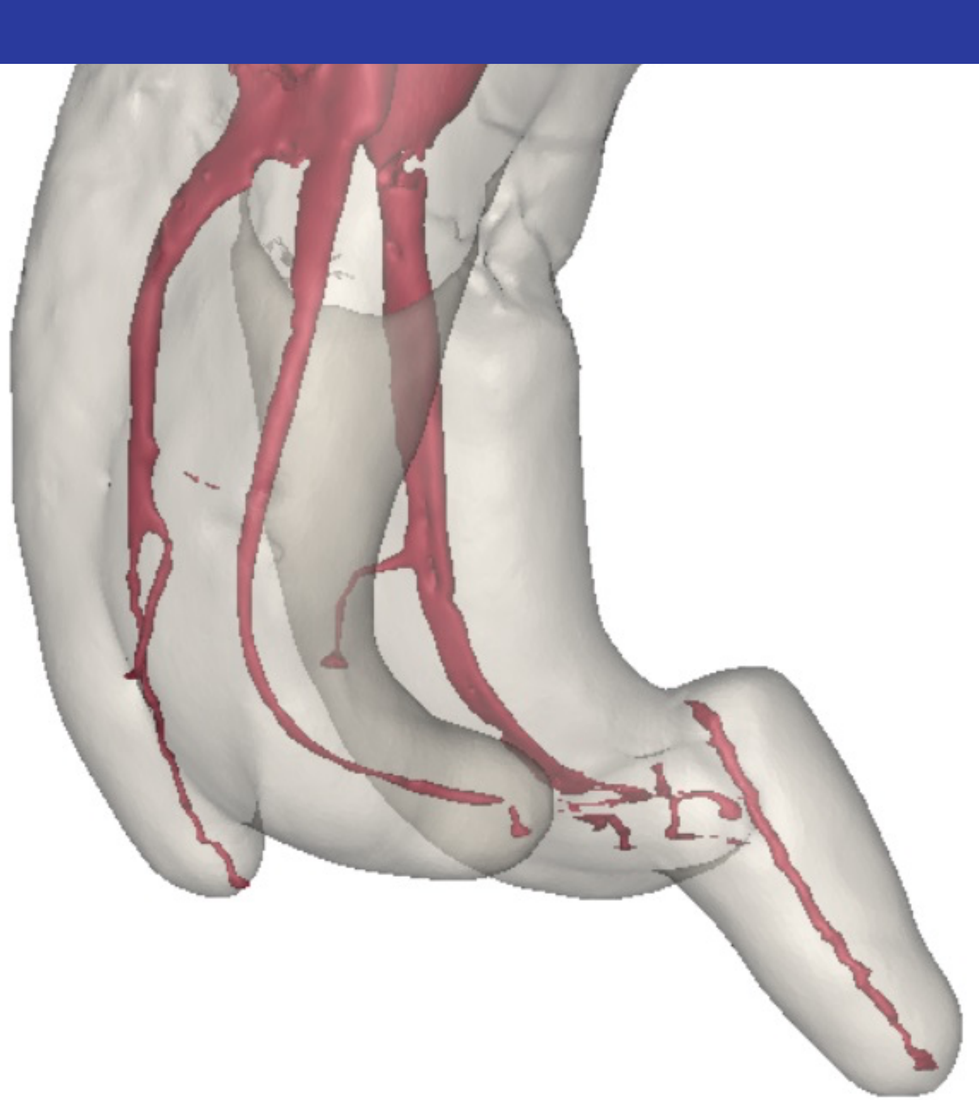

Anatomical Challenges

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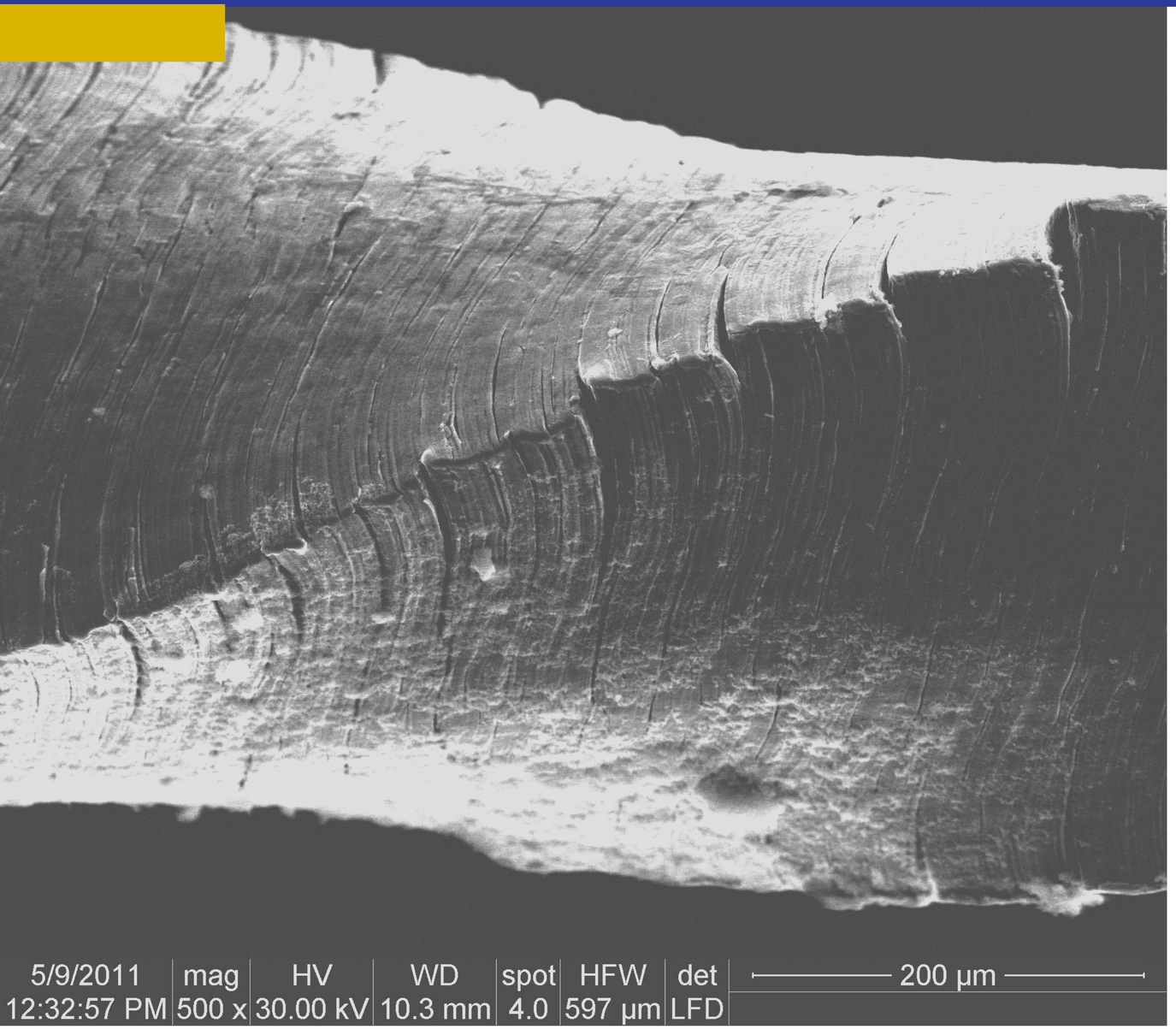

Mechanical Limitation

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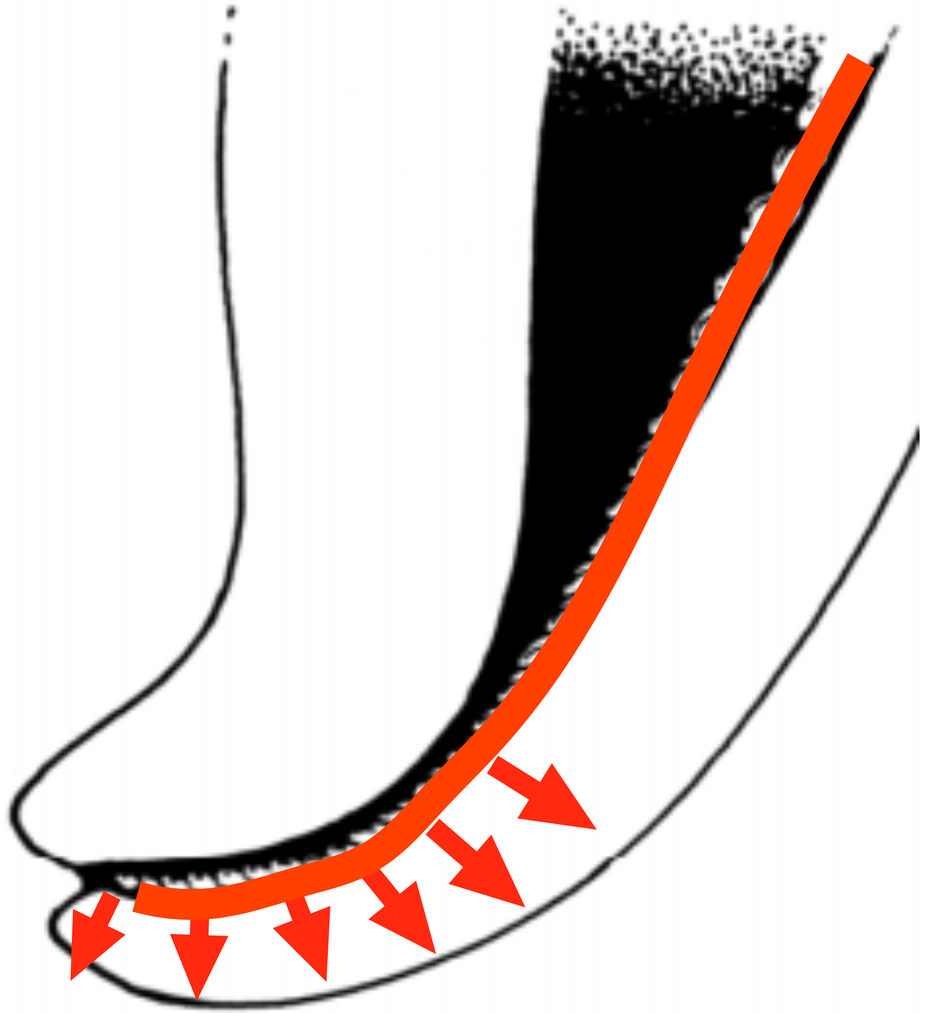

Peters OA, J Endod 2004: 30: 559–567.
Bergmans L et al, Am J Dent 2001: 14: 324–333.
Saunders EM, Endod Topics 2005: 10: 163–167.
Young GR et al Aust Dent J Endod 2007: 52(Suppl): S52–S63.

LEDGE

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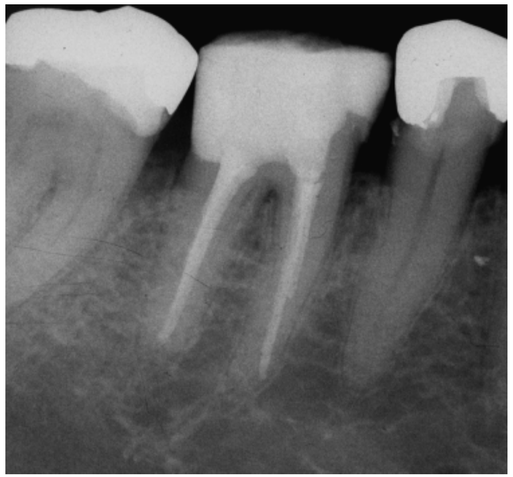
Problems with curved root canals

- Transportation
- Zip formation
- Elbow formation
- Perforation
- Strip perforation
- Ledging



Schäfer & Dammaschke, (2006) Endodontic Topics, 15, 75–90.

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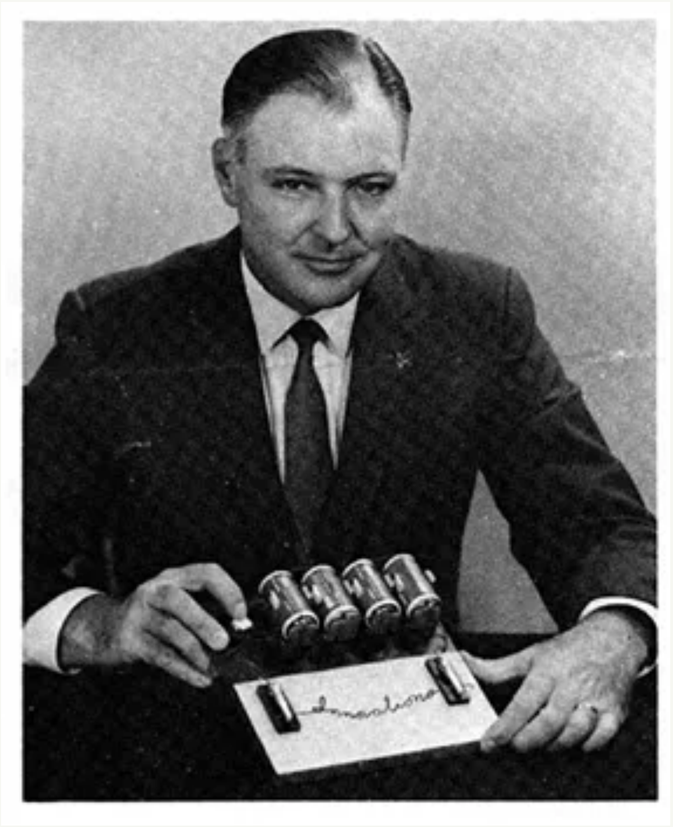
I think I should
do something

Nickel Titanium for the Naval Ordinance Laboratories



NiTinol

1960

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0099-2399/88/1407-0346/$02.00/0
JOURNAL OF ENDODONTICS

Printed in U.S.A.
VOL. 14, NO. 7, JULY 1988

An Initial Investigation of the Bending and Torsional Properties of Nitinol Root Canal Files

Harmeet Walia, BDS, MDS, MS, MS, William A. Brantley, BS, MS, PhD, and Harold Gerstein, BS, DDS

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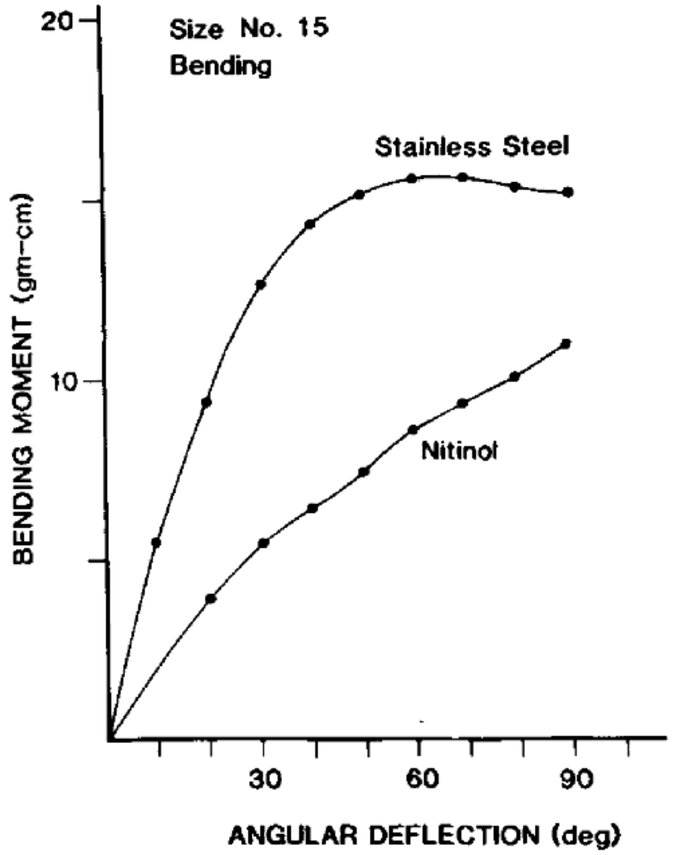


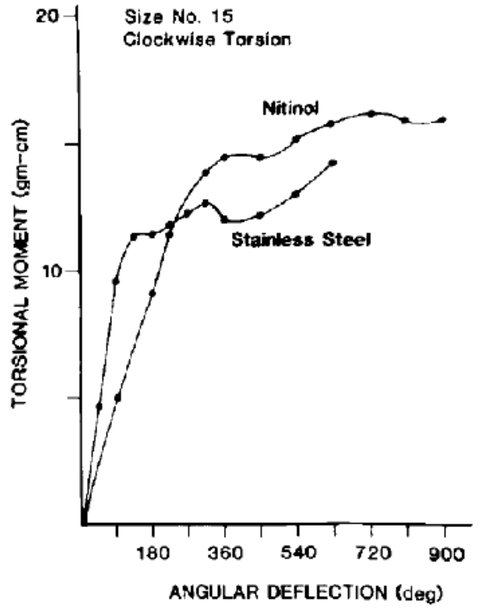
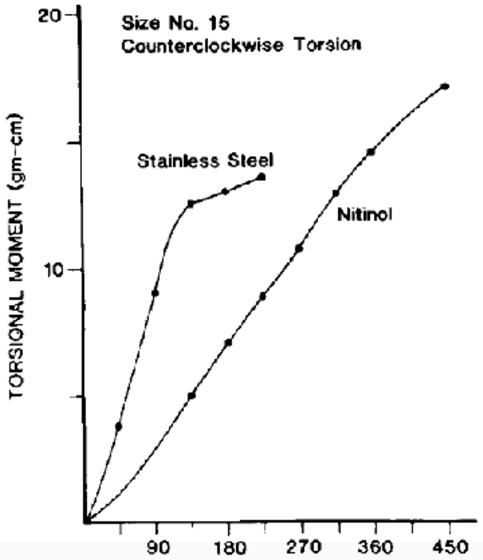


FIG 6. Clockwise torsion test results for the size #15 Nitinol and stainless steel files.



Superelasticity

Austenite

Deformed martensite

Zupanc et al 2018

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Advantages

Flexibility

Time

Comparative study of six rotary nickel–titanium systems and hand instrumentation for root canal preparation

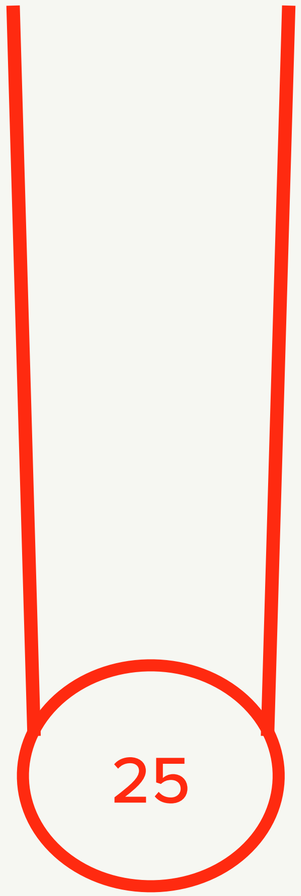
Guelzow et al, Int Endod J 38, 743–752, 2005

Table 6 Time to complete root canal preparation (s)

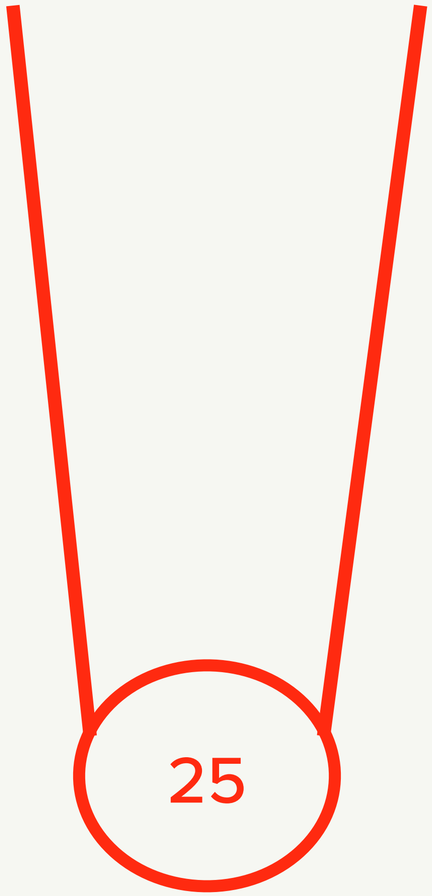
System	*n*	Mean	SD
FlexMaster[A]	21	102.9	46.3
System GT[A]	20	93.5	34.0
HERO 642[B]	20	186.1	92.0
K3[C]	20	114.2	40.8
ProTaper[B]	18	152.0	46.8
RaCe[B]	21	207.6	223.9
Manual technique[D]	20	1179.8	536.6

[A,B]Means with the same letters are not significantly different.

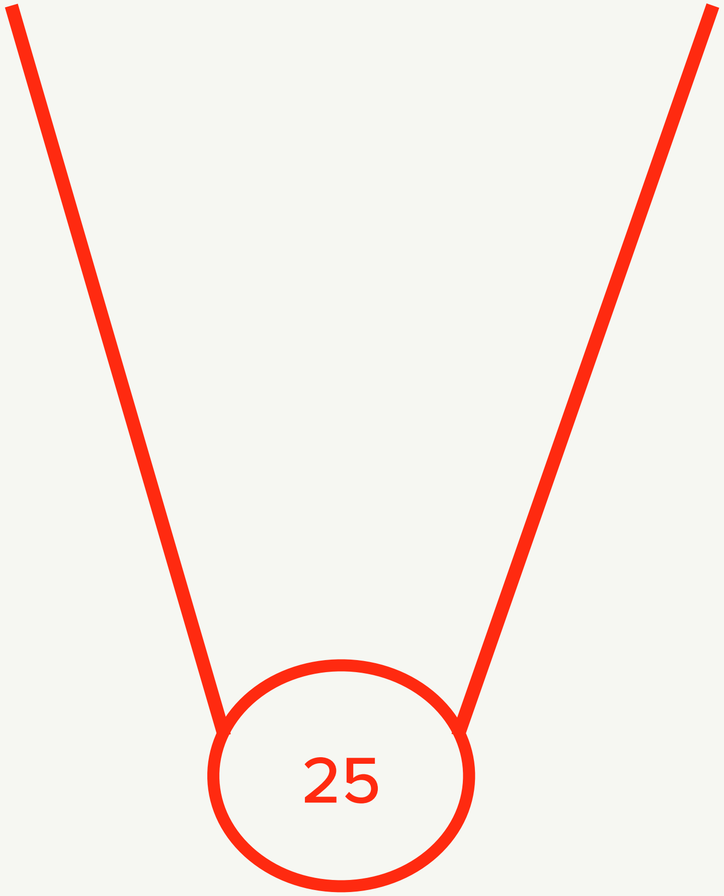
Deep Shape



2%

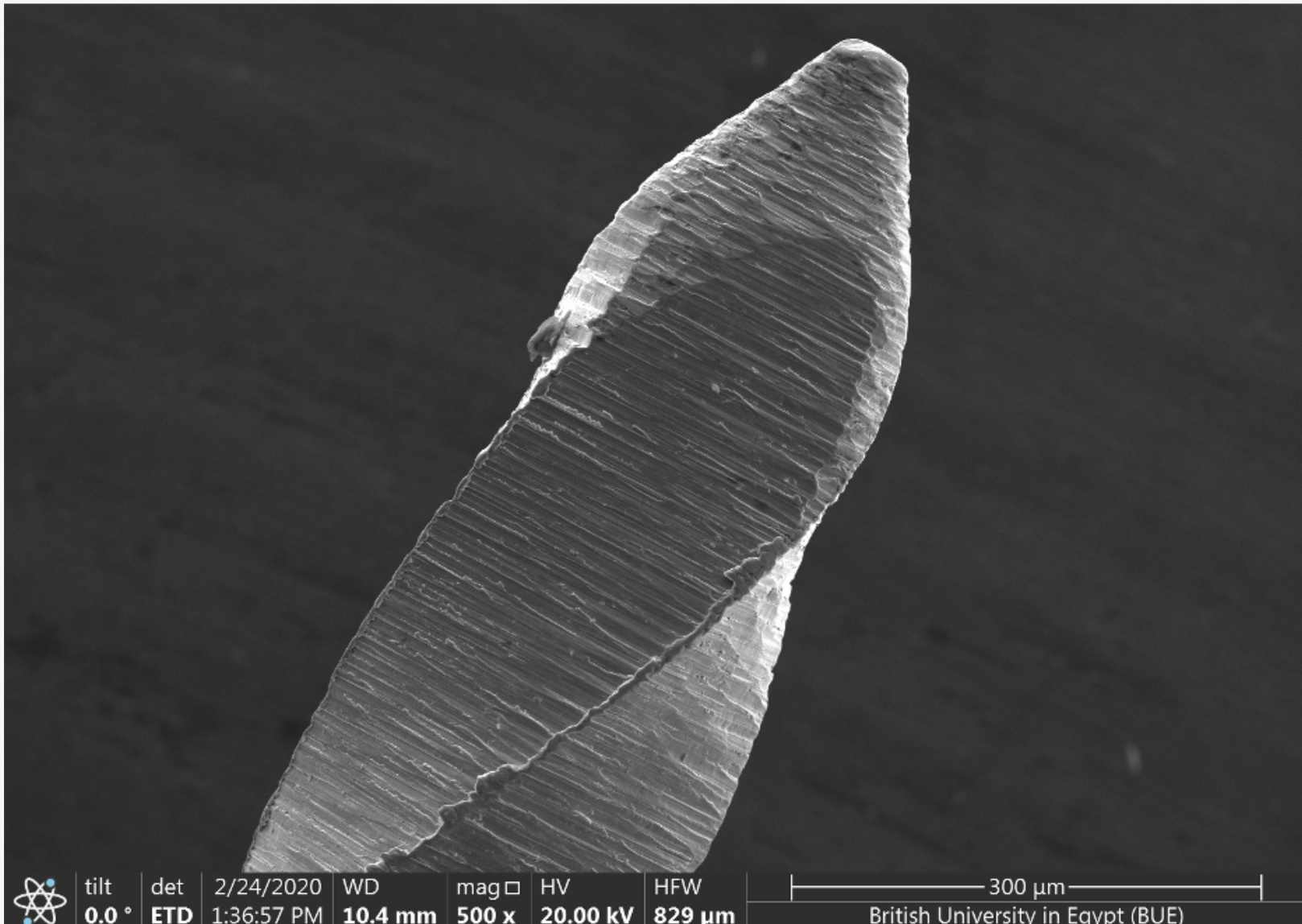


4%



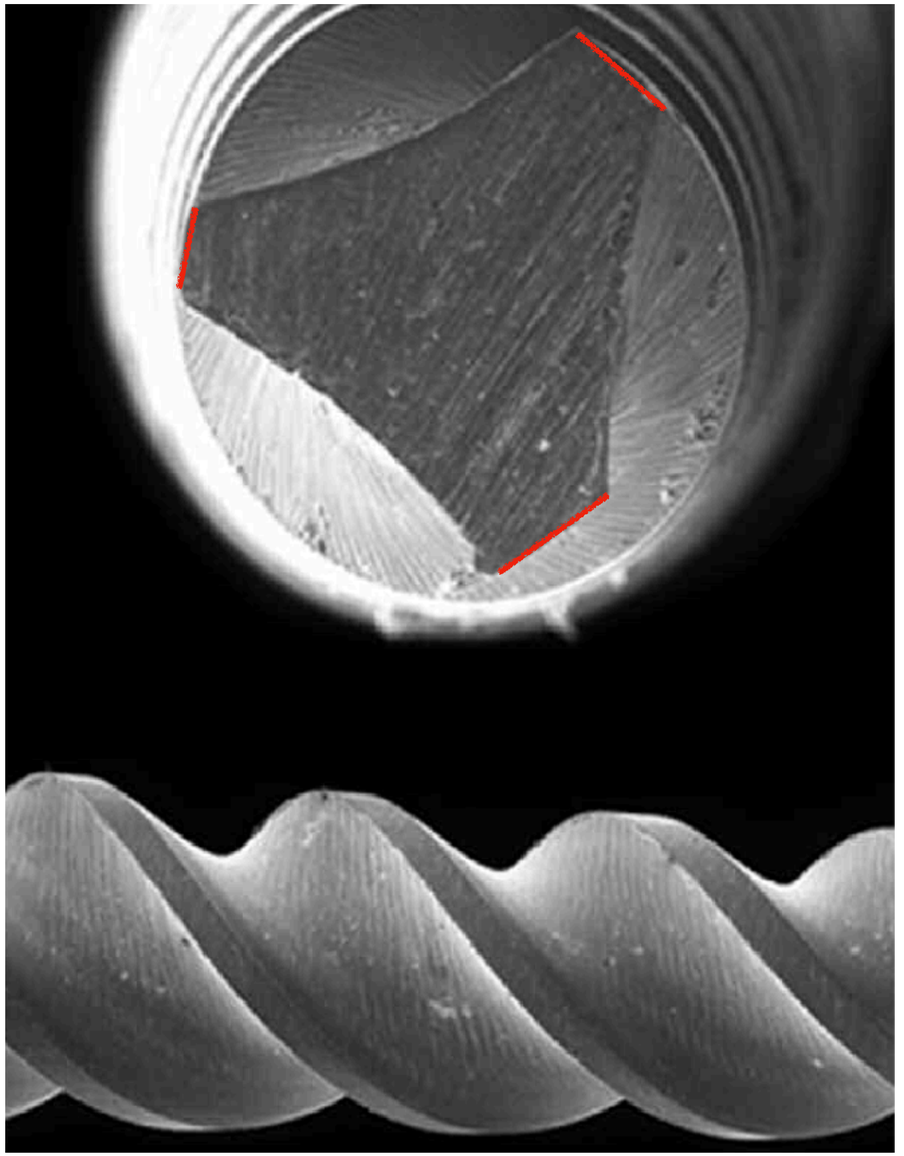
6%

Tip design


tilt
0.0 °
det
ETD
2/24/2020
1:36:57 PM
WD
10.4 mm
mag
500 x
HV
20.00 kV
HFW
829 µm
300 µm
British University in Egypt (BUE)

First Group

- ✦Radial Land
- ✦Passive Cutting Edge



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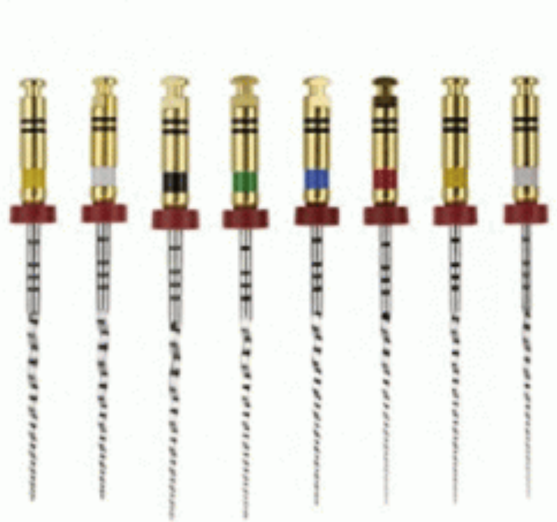
First Group

✦Fixed Taper (4%, 6%…)
✦Numerous files/kit

LightSpeed

Quantec



ProFile

System GT

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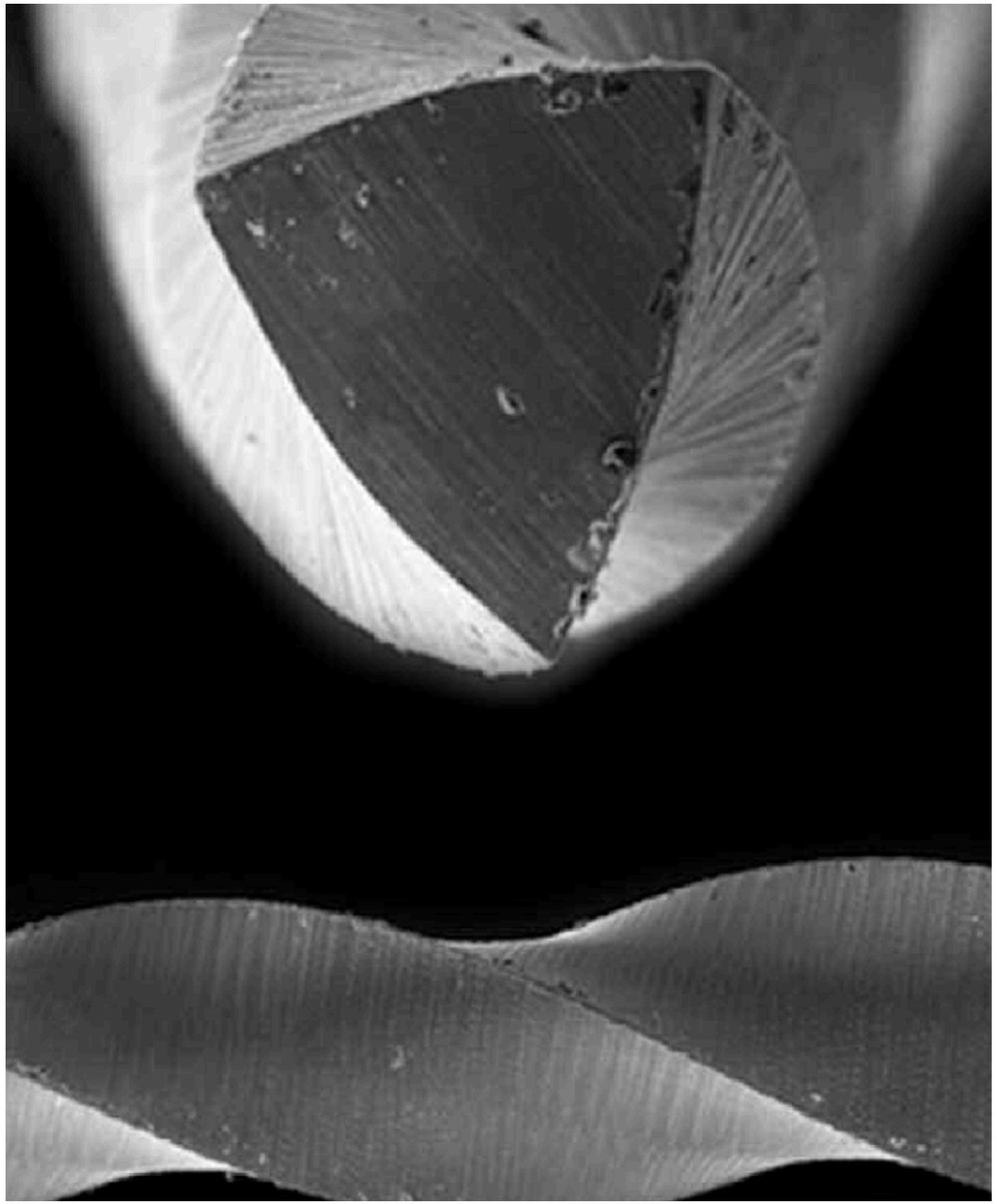
Second Group

✦Active Cutting Edge



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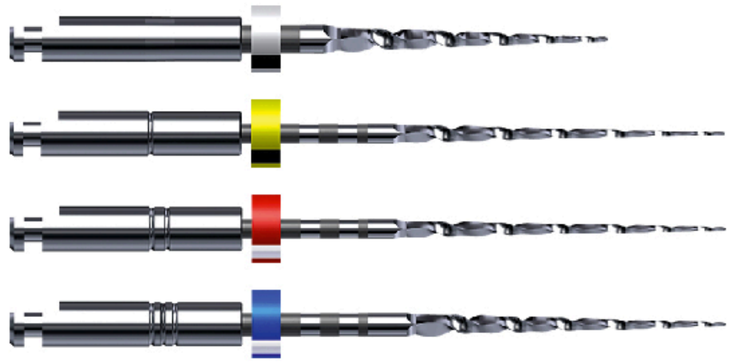
Second Group

- ✦Variable Taper
- ✦Lesser Files
- ✦Alternating Cutting edge
- ✦Electropolishing

ProTaper

RaCe



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Third Group

m-wire®
nickel titanium

✦Change in Metallurgy

TF®

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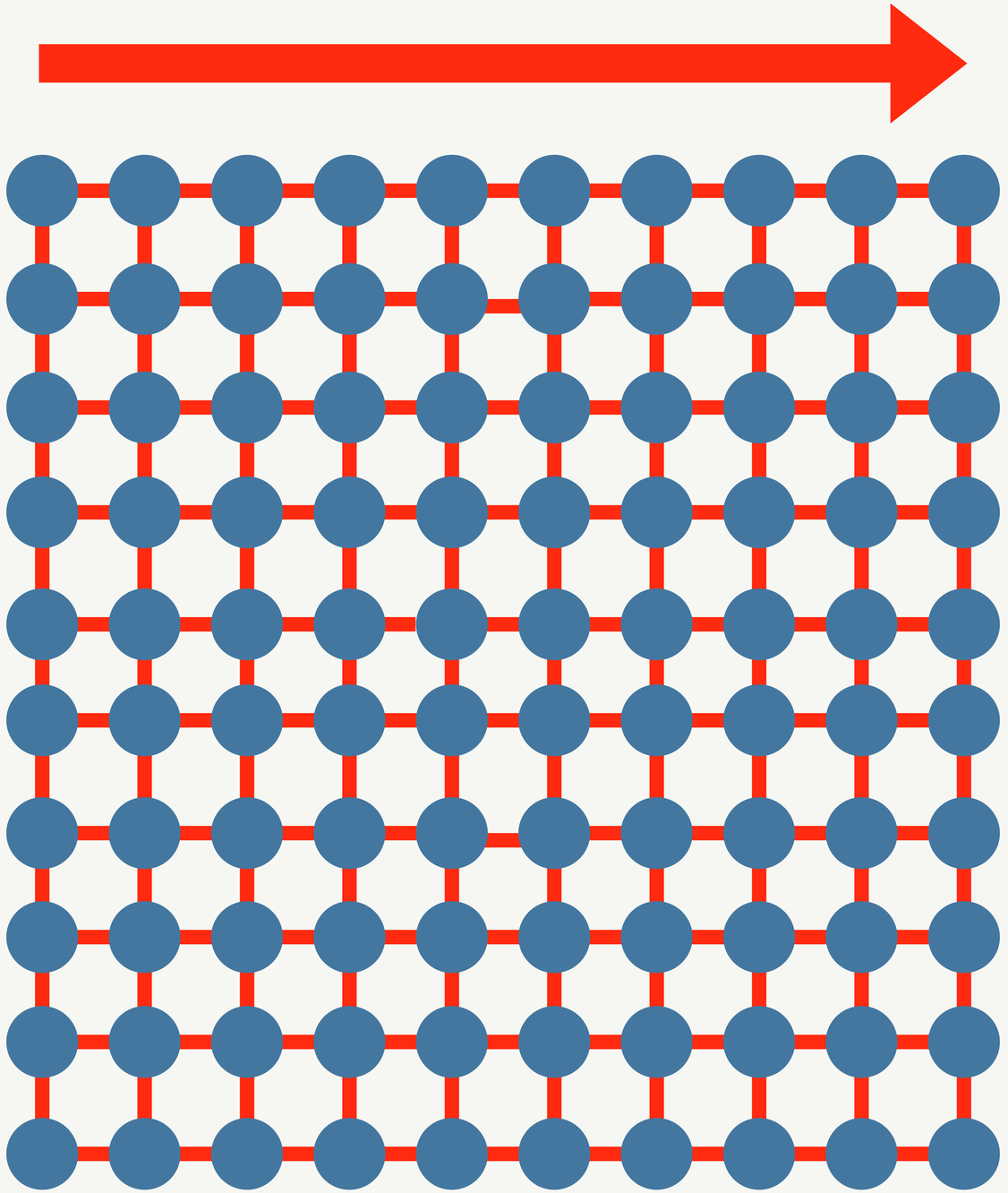
Room

Temp.



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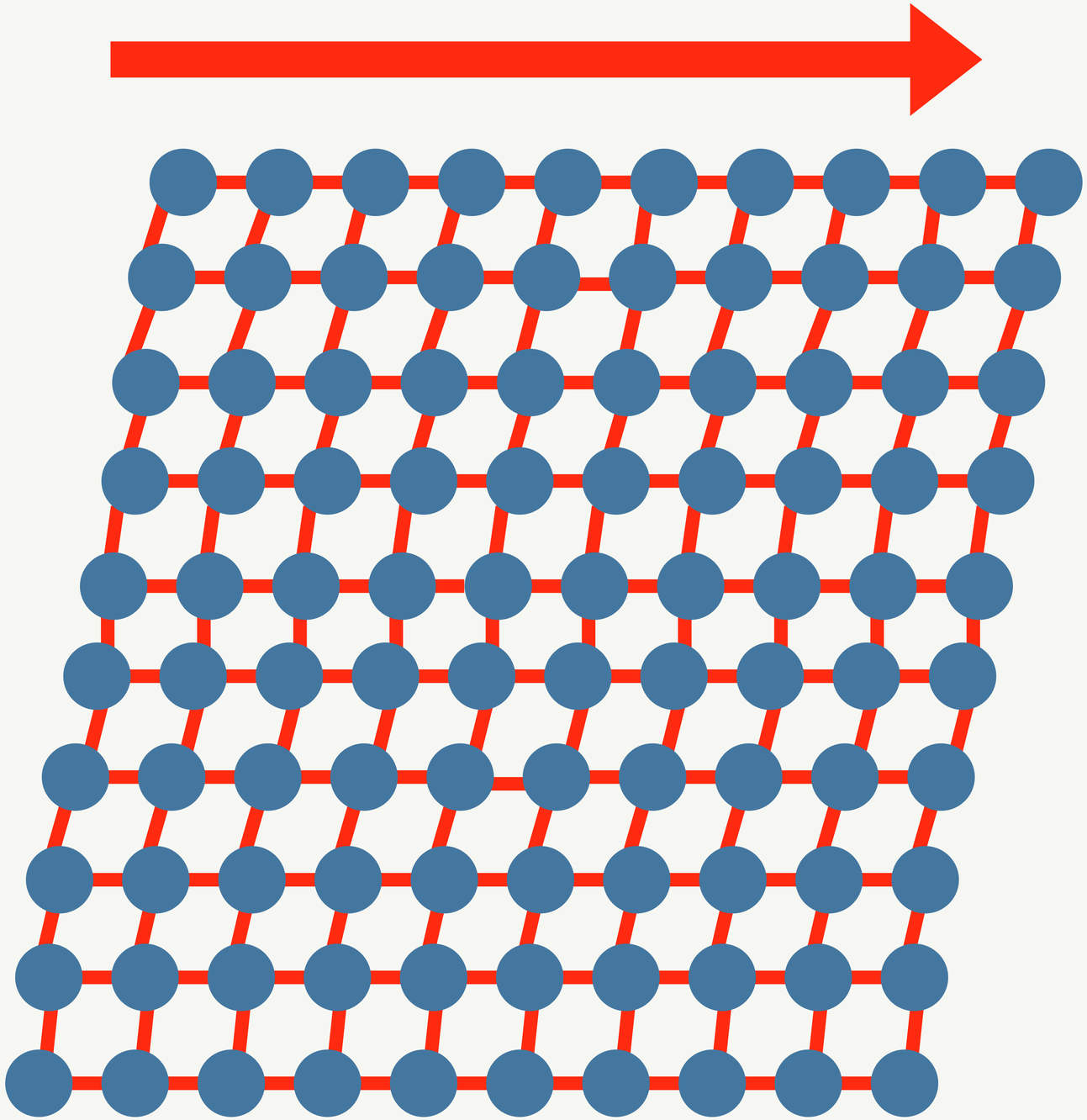
Room

Temp.



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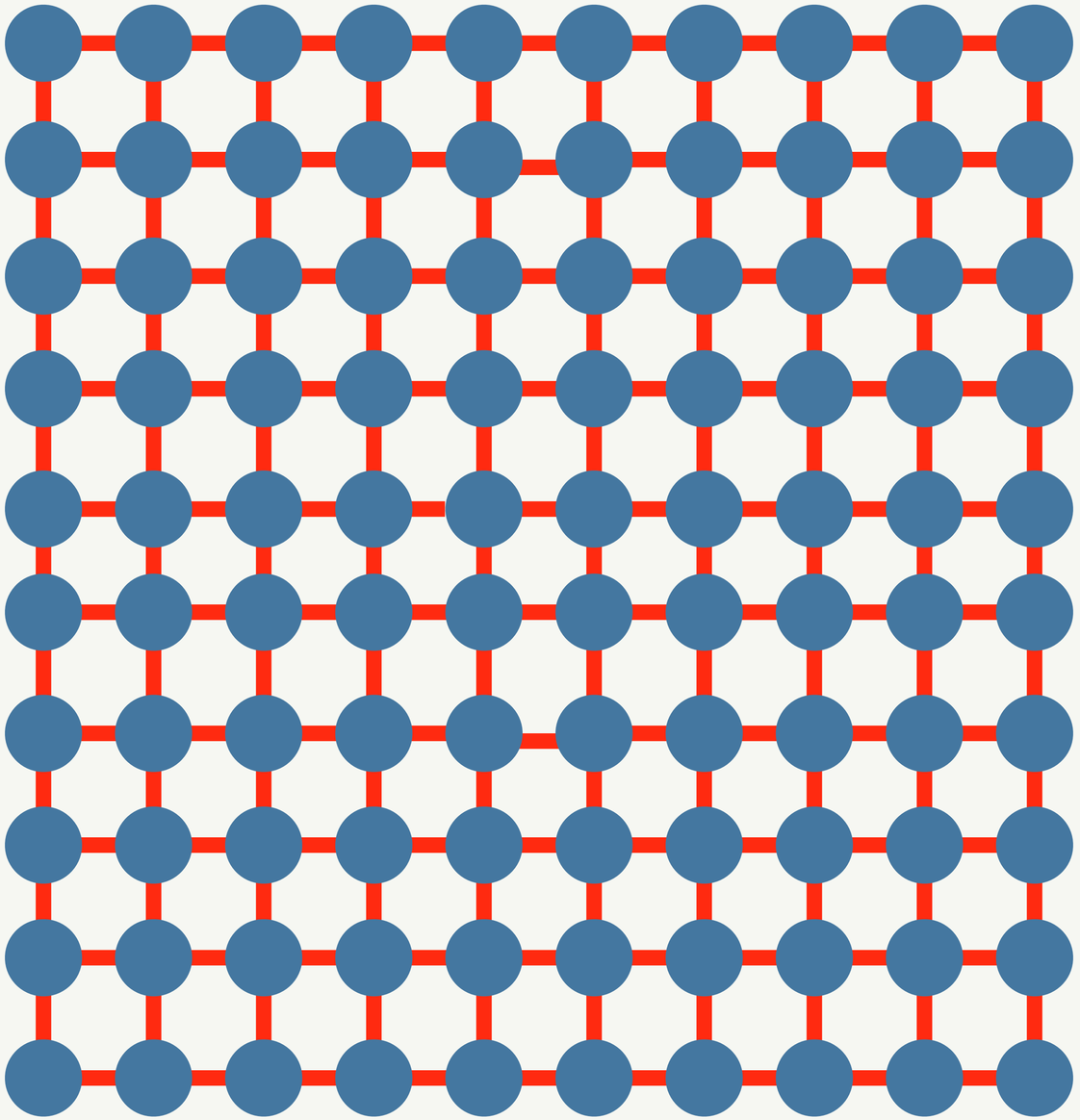
Room

Temp.



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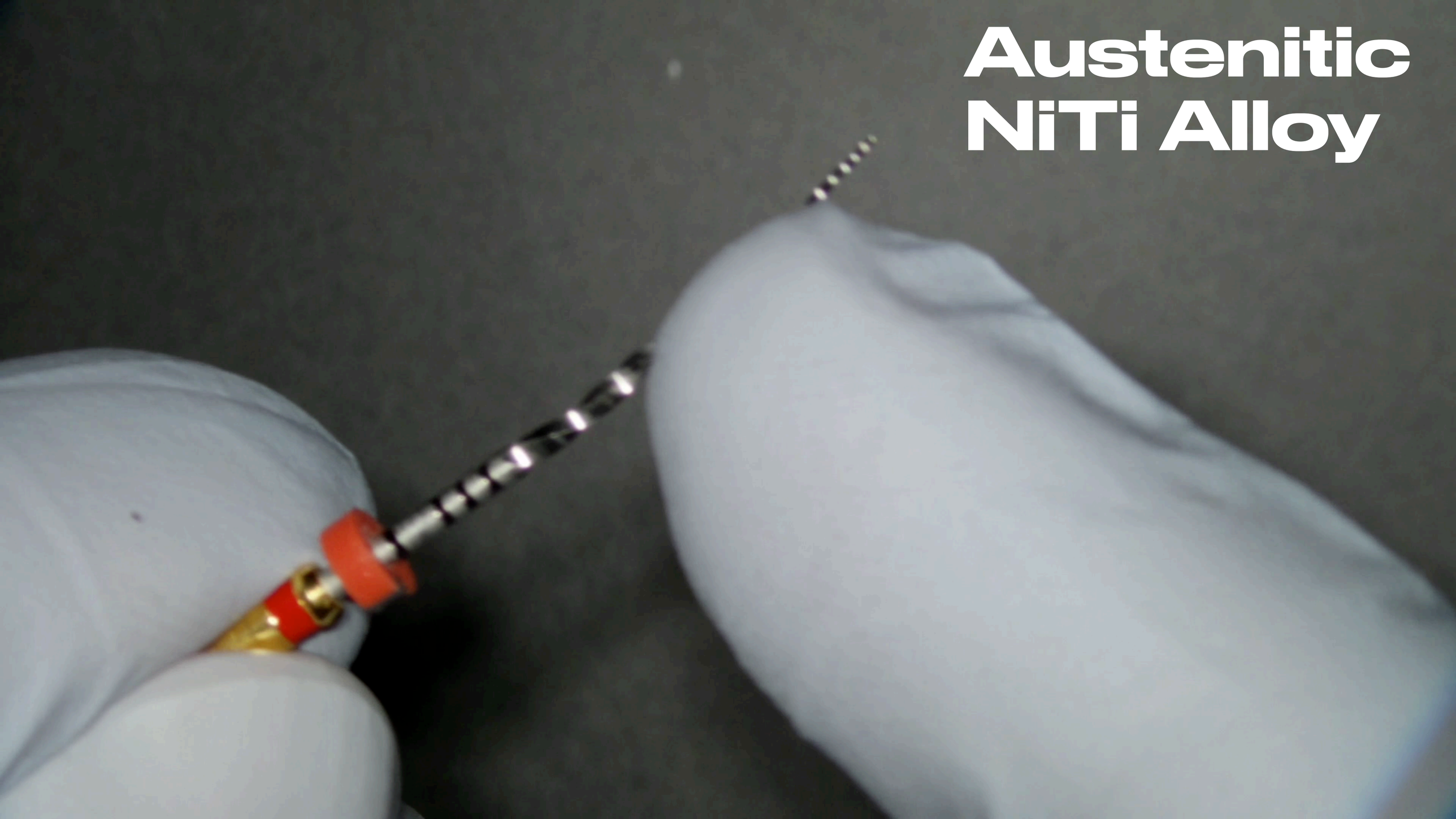
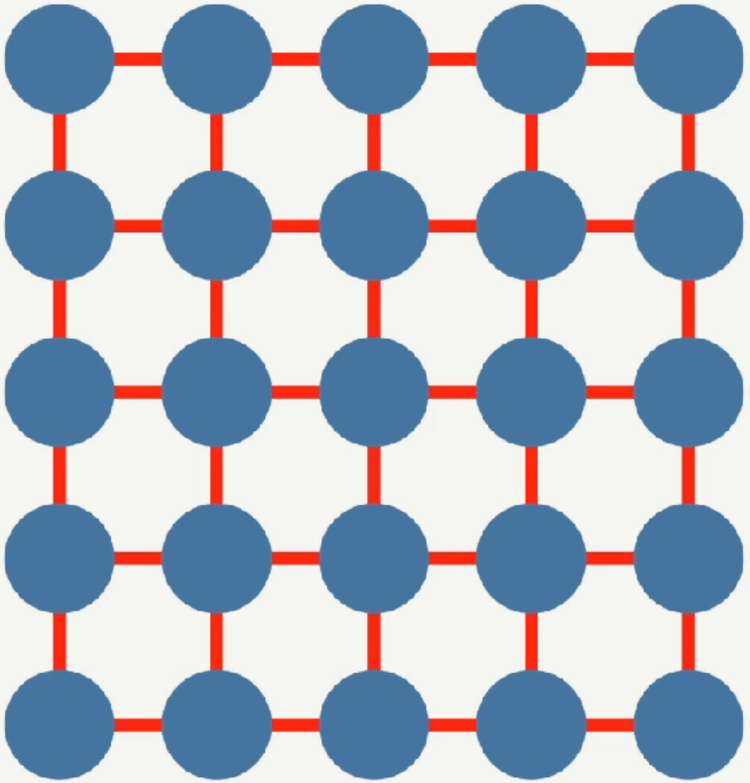
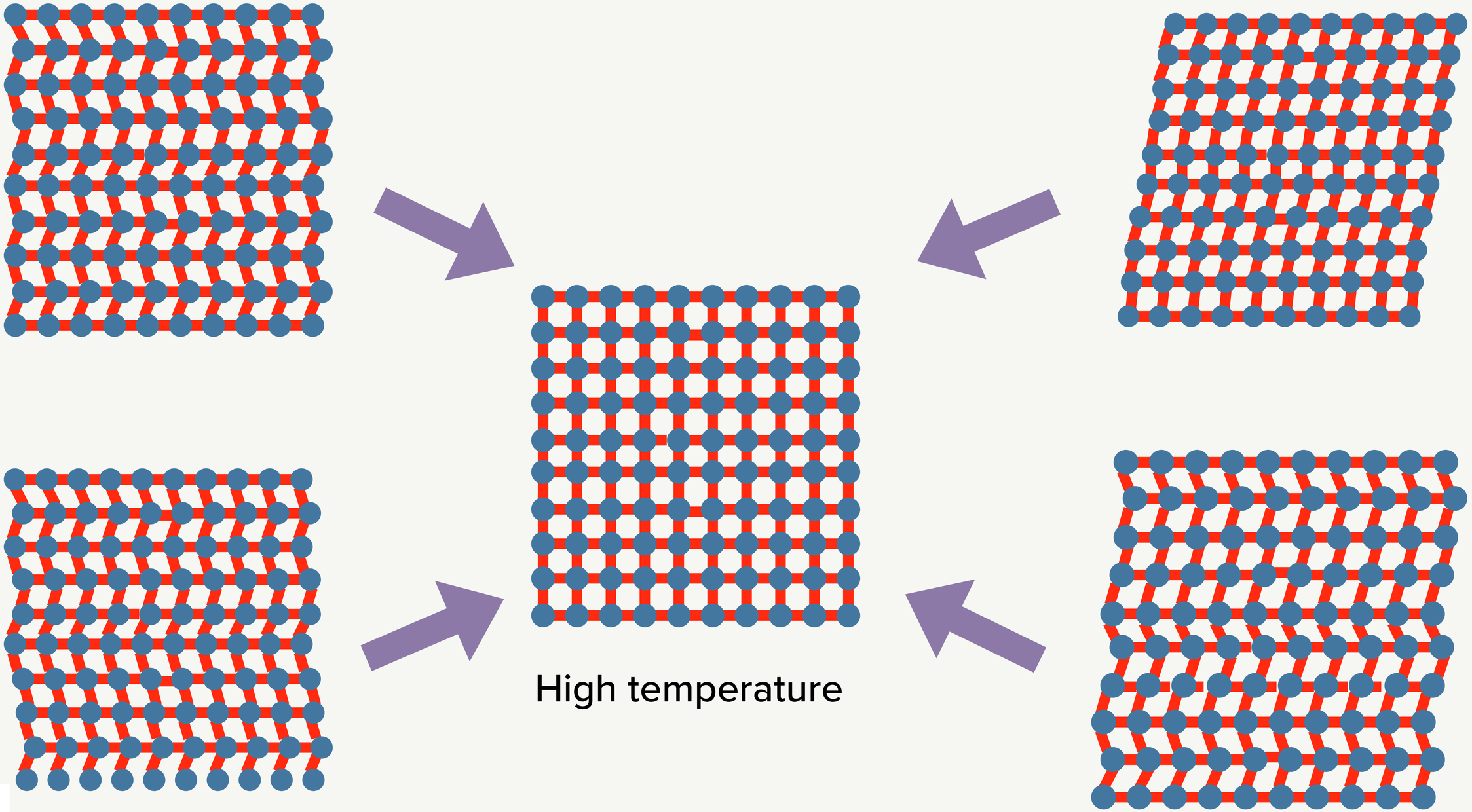

Austenitic
NiTi Alloy





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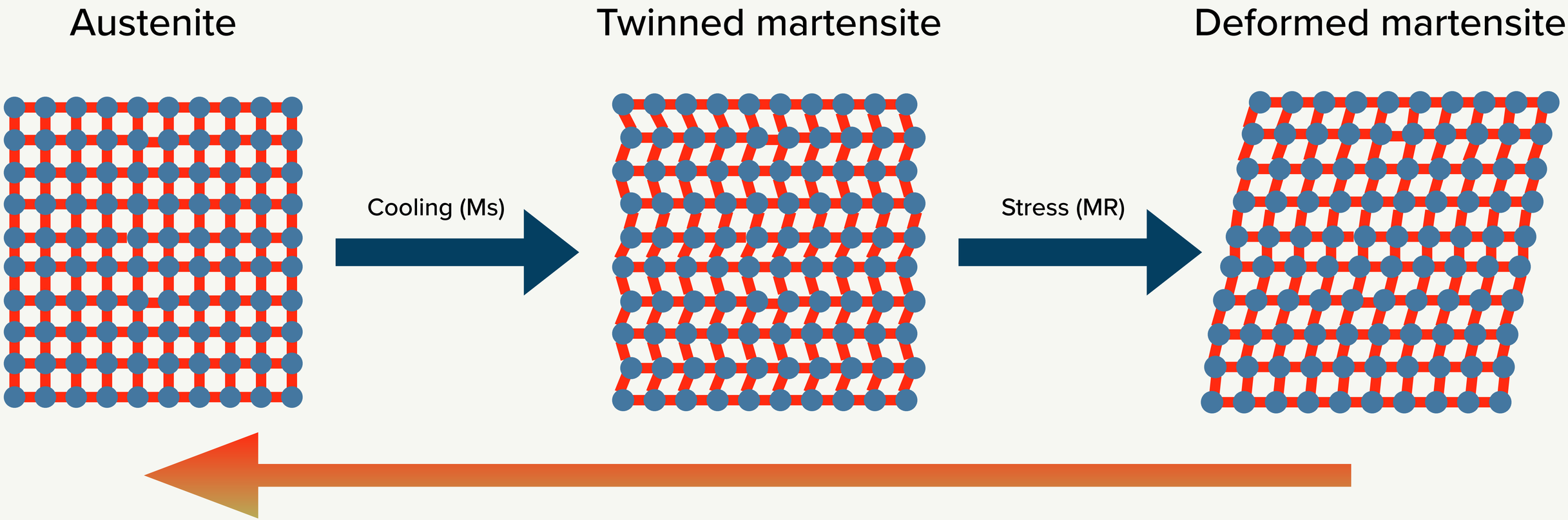
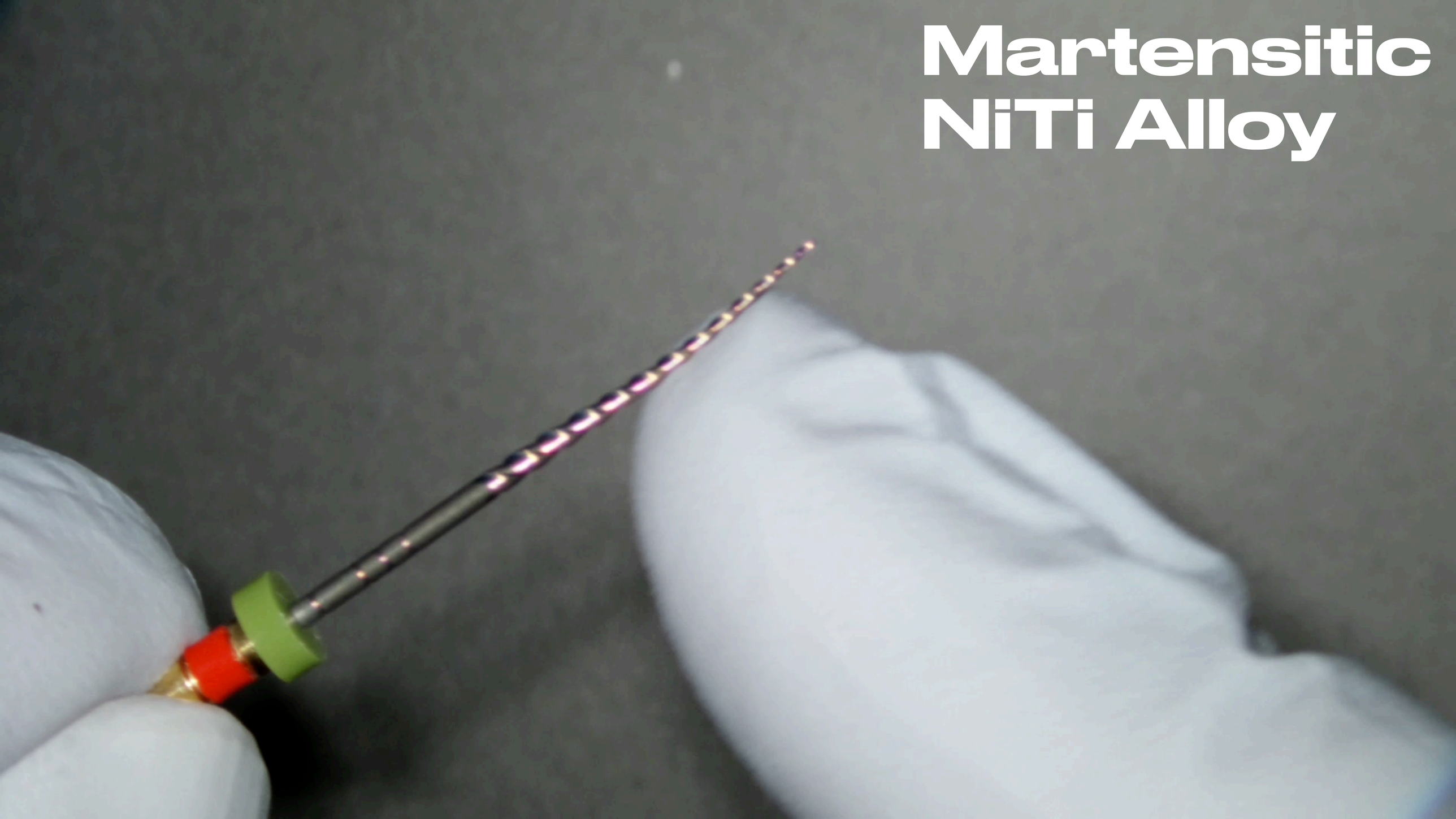
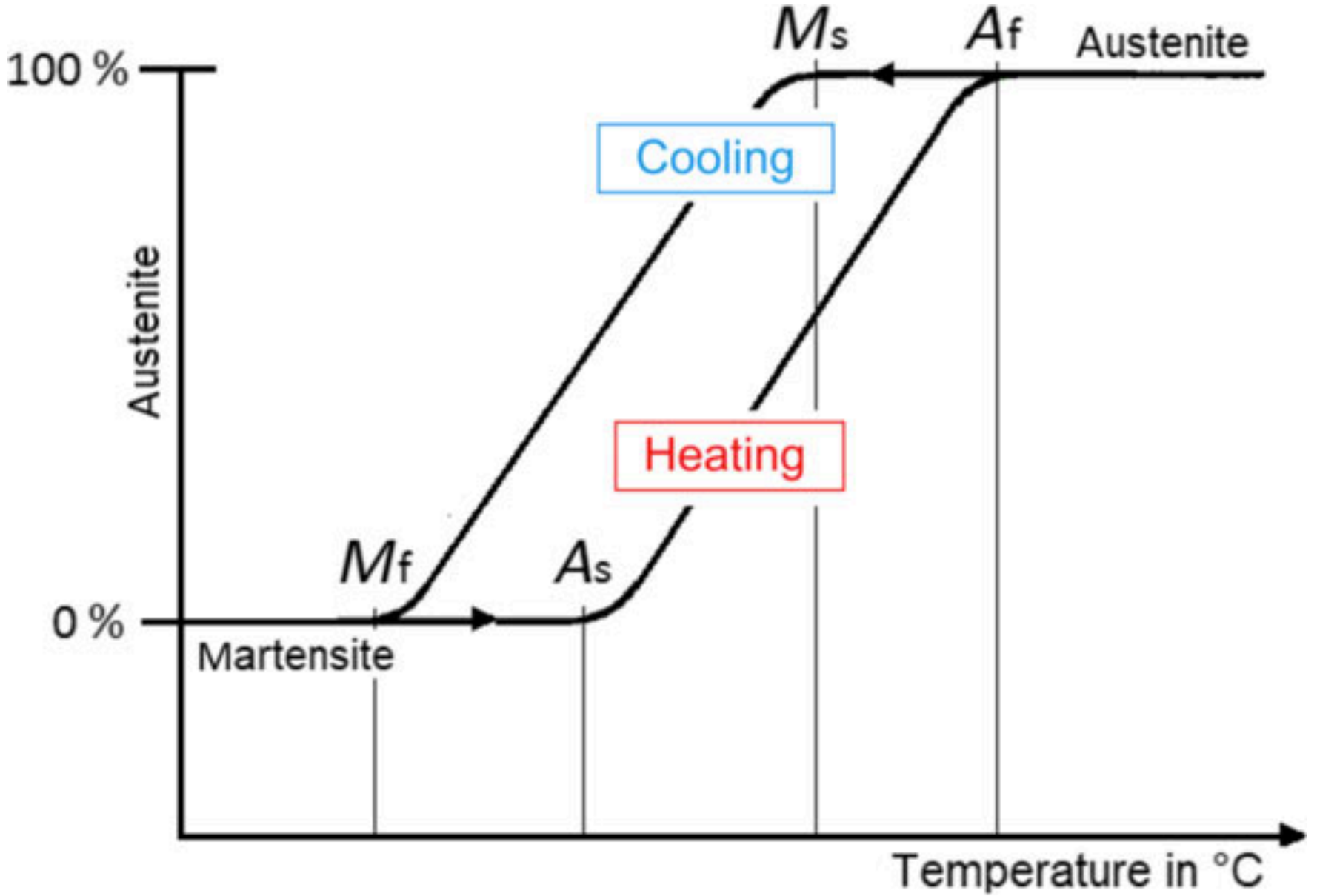
Shape Memory Effect



Zupanc et al 2018

THE UNIVERSITY OF WESTERN AUSTRALIA


Martensitic
NiTi Alloy



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Austenitic NiTi

- Af temperature is at or below room temp.
- Superelastic.
- High cutting efficiency.
- High torque resistance.
- Low cyclic fatigue resistance.

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m-wire®
nickel titanium

- thermomechanical processing
- unique nanocrystalline martensitic microstructure
- austenite finish temperature of M-wire was found to be around 43–50°
- phases that are in both the deformed and microtwinned martensitic, R-phase, and are austenite whilst maintaining a pseudoelastic state

THE UNIVERSITY OF WESTERN AUSTRALIA

m-wire®

nickel titanium

higher strength and wear resistance and more fatigue resistance

ProTaper Next®

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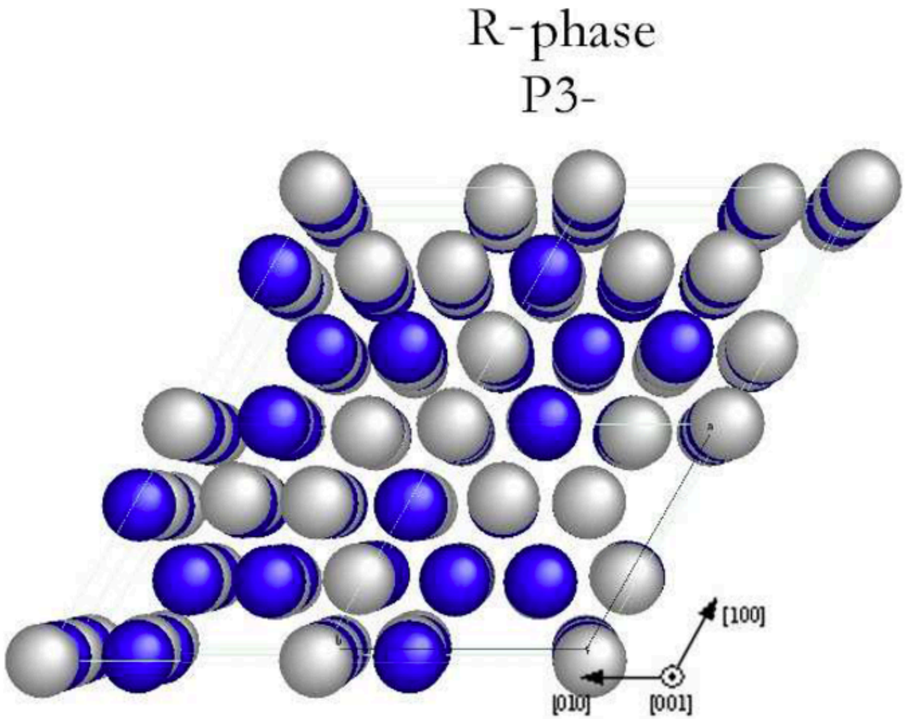
R- Phase



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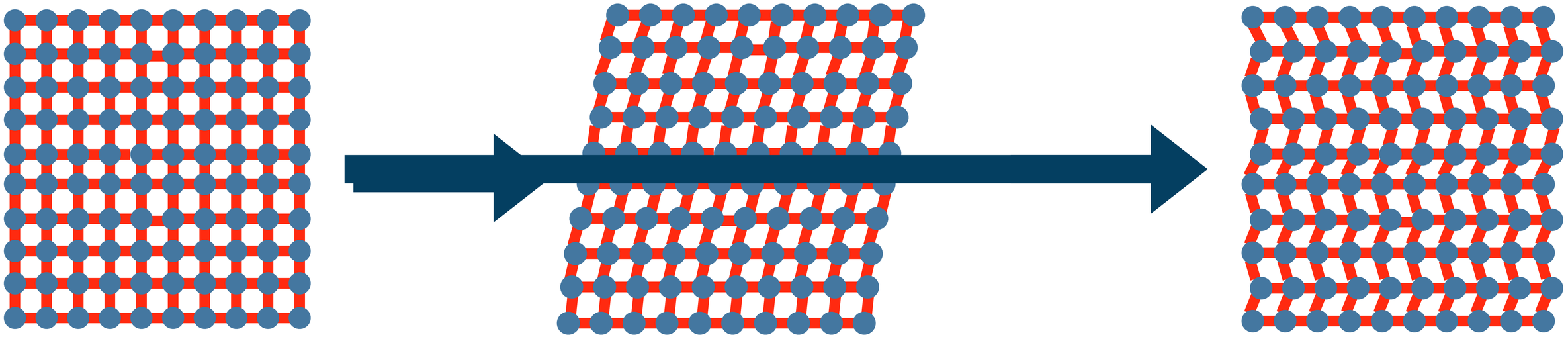
R- Phase



Austenite

R- Phase

Martensite

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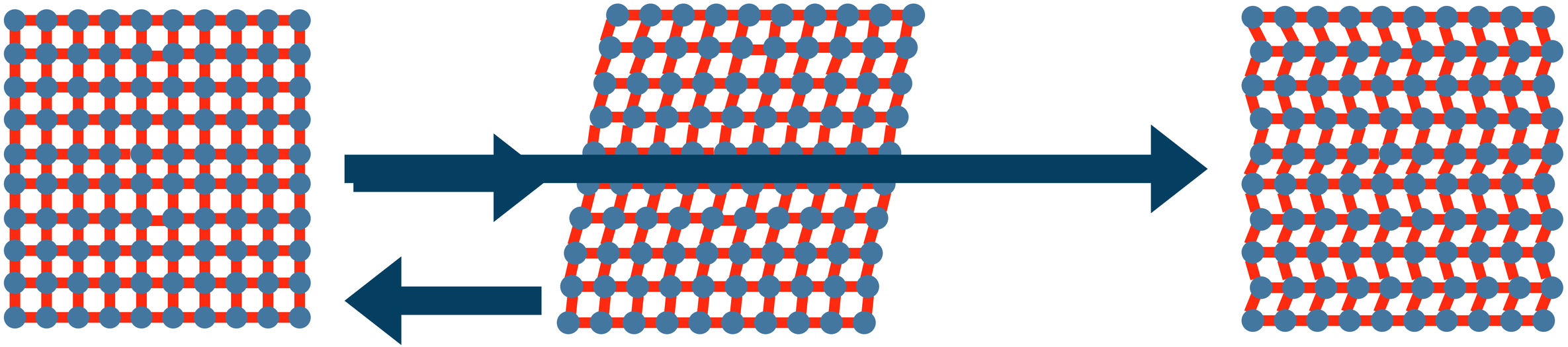
R- Phase



Austenite

R- Phase
Twisting

Martensite

THE UNIVERSITY OF WESTERN AUSTRALIA

R- Phase

lower shear modulus

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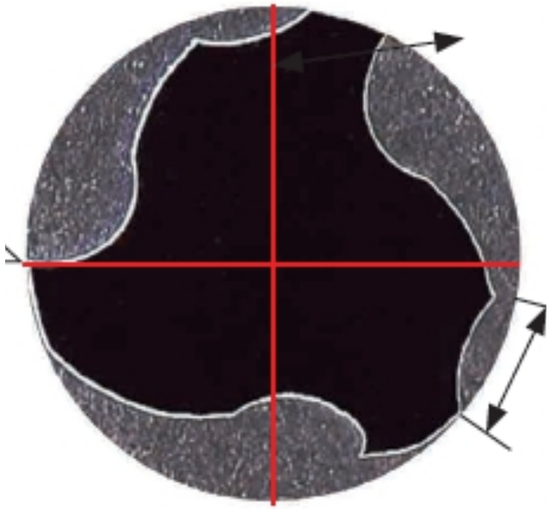
R- Phase

K3XF™

a post-machining R-phase heat treatment



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R- Phase

- Superior fatigue resistance
- Less stress needed to SIM transformation
- Superior flexibility

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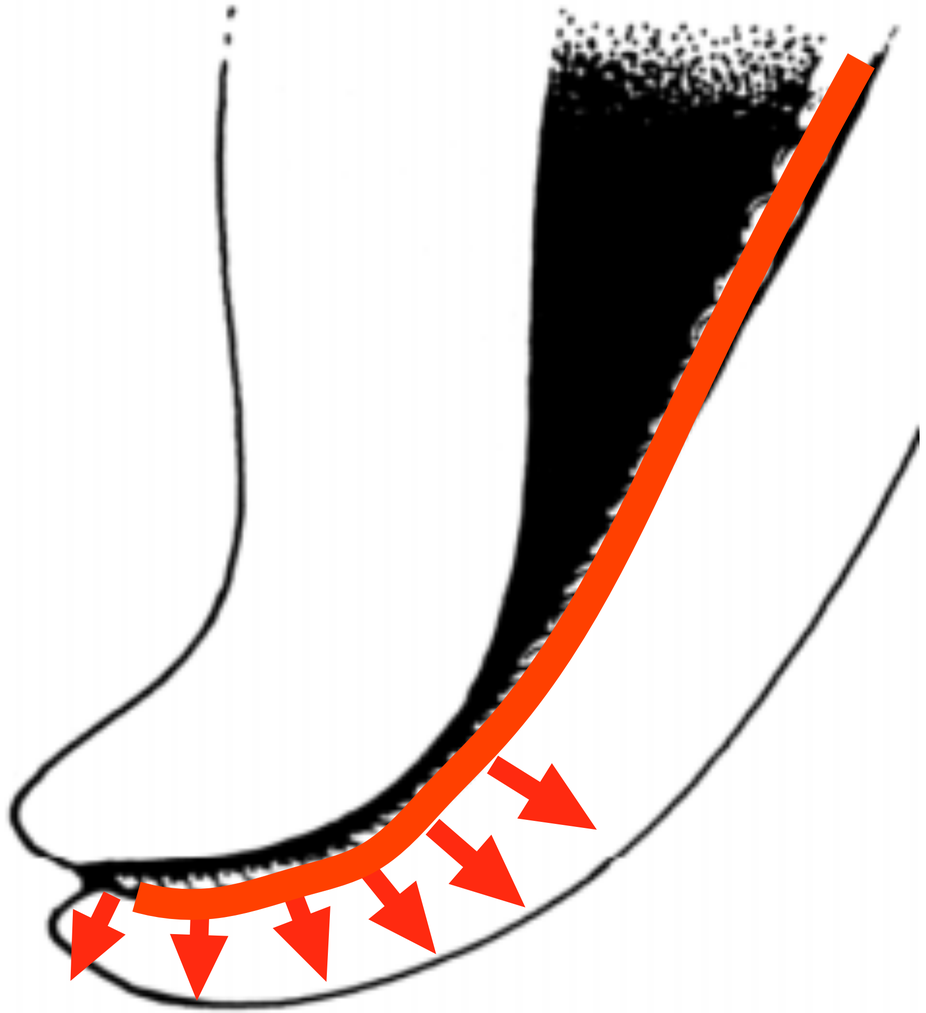
Austenitic NiTi

- Conventional NiTi
- Electropolished NiTi
- M-wire
- R-phase



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Young GR et al Aust Dent J Endod 2007: 52(Suppl): S52–S63.

Martensitic NiTi

- Ductile
- Easily deformed

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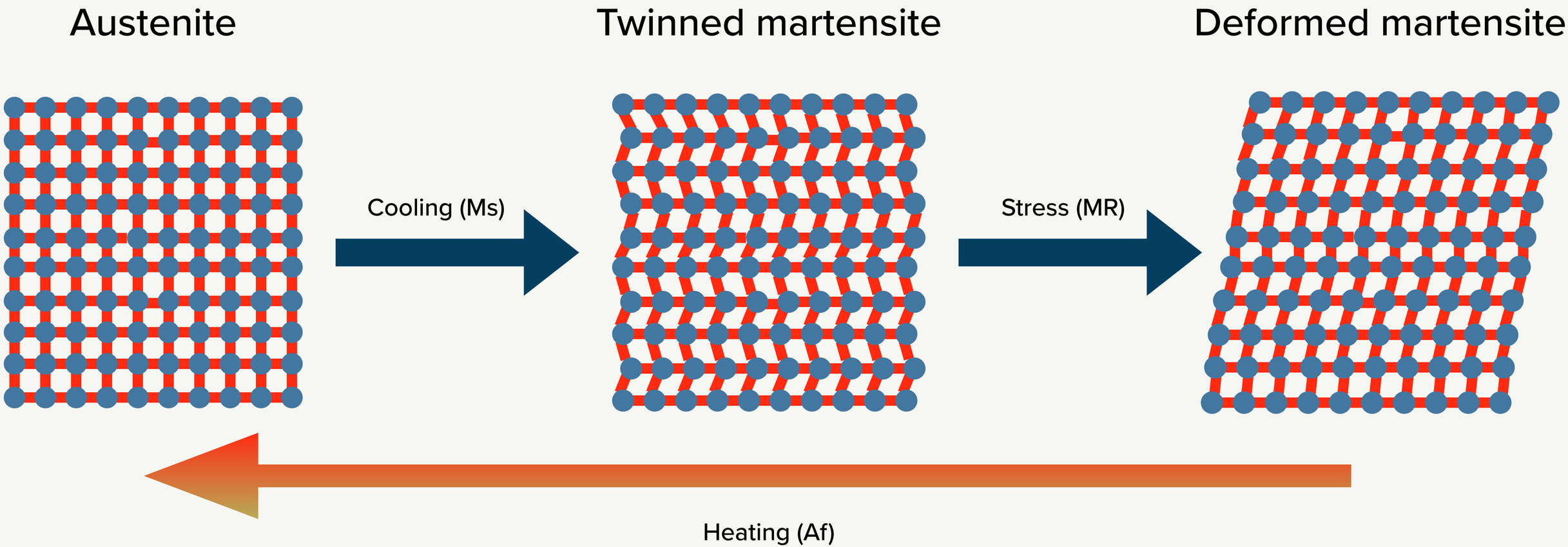
Shape Memory Effect

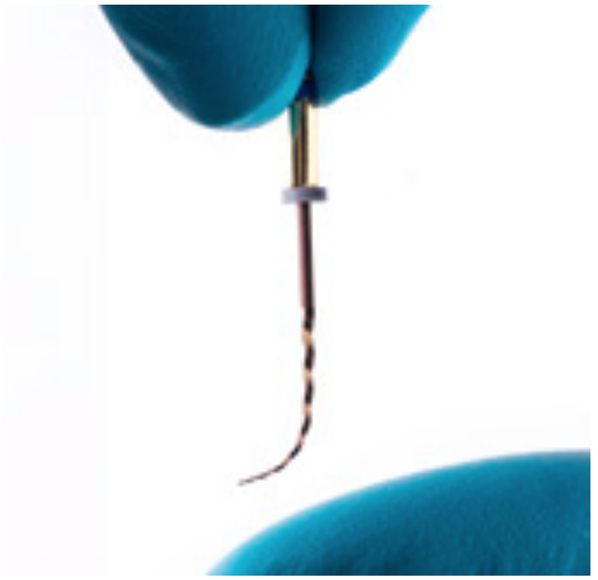


Zupanc et al 2018

CM- Wire

- The first thermomechanically treated NiTi alloy that does not possess superelastic properties at neither room nor body temperature.
- CM Wire instruments do not tend to fully straighten during

HyFlex™ CM



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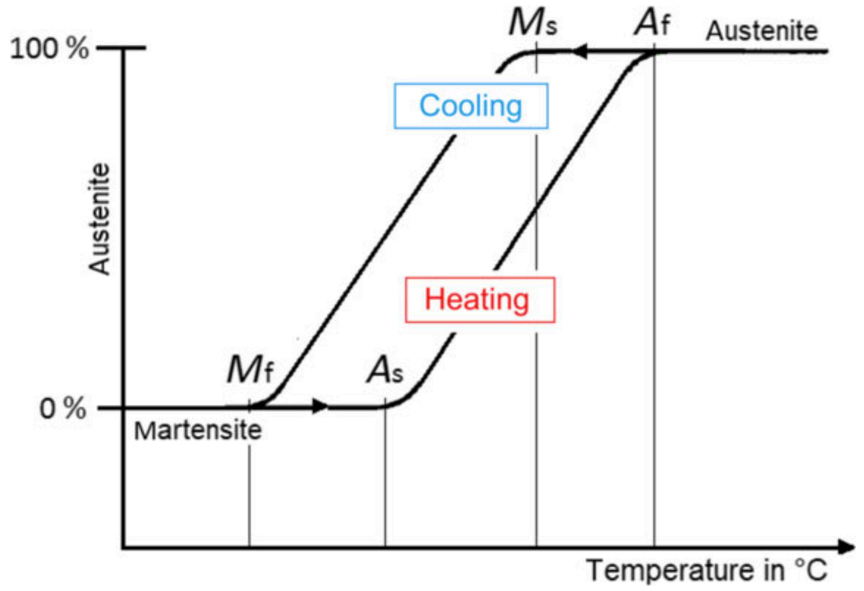
CM- Wire

HyFlex™ CM

- austenite finish temperature of CM Wire instruments is around 47–55 °C
- mixture of austenite and martensite structure with small amounts of the R-phase at room temperature.



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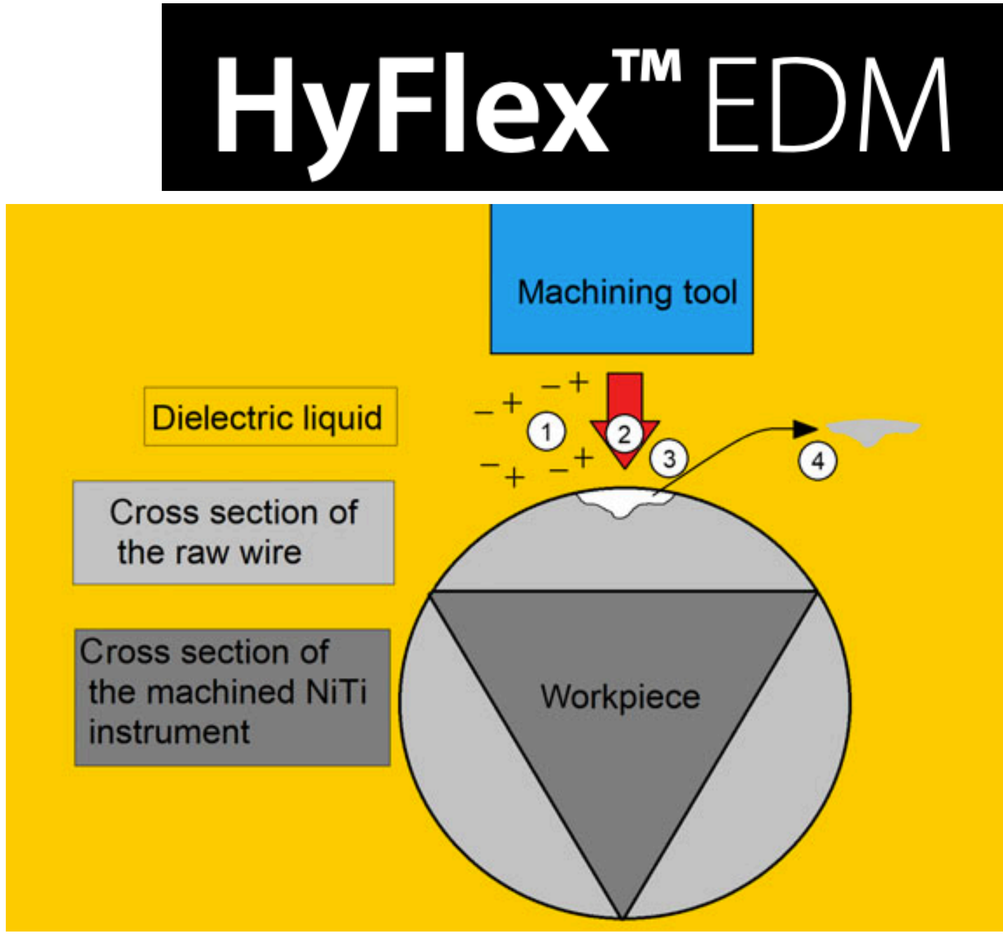
CM- Wire

- harden the surface of the NiTi file
- improved fracture resistance
- superior cutting efficiency



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VORTEXBLUE™
ROTARY FILES

RECIPROC® blue

VDW.ROTATE™

- Af of is around 38°C, Ms around 31°C.
- mainly contain martensite and R-phase under clinical conditions
- Postmachining heat treatment

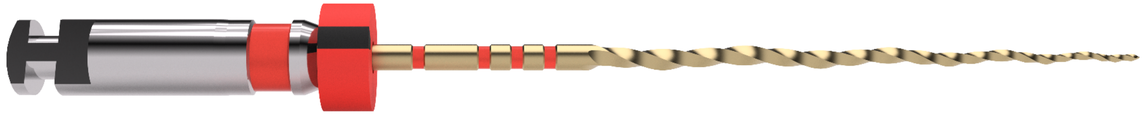
- Af of is around 38°C, Ms around 31°C.
- Postmachining heat treatment
- greater amount of stable martensite
- Ductile

ProTaper Gold®

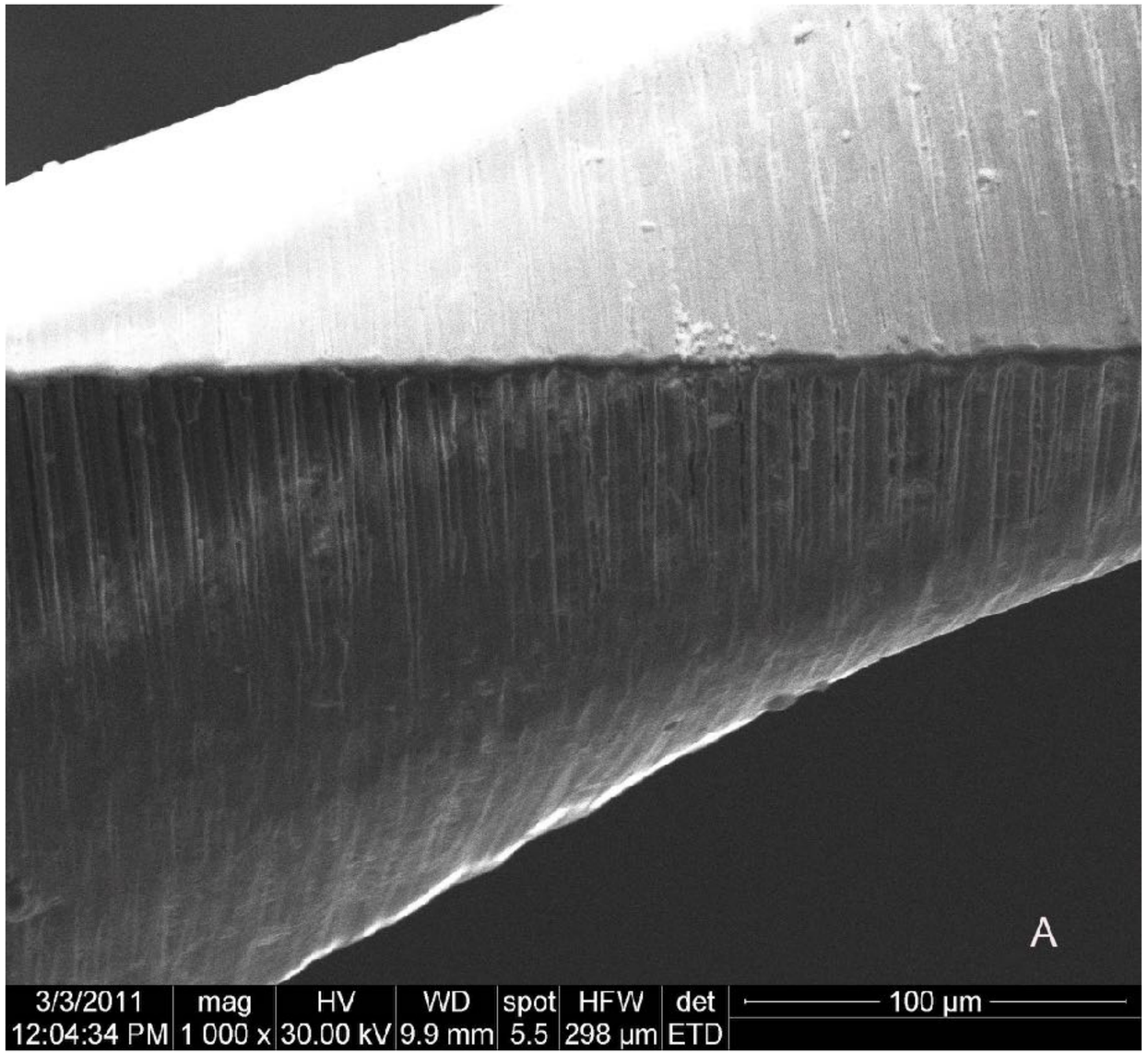
WaveOne® Gold

MAILLEFER

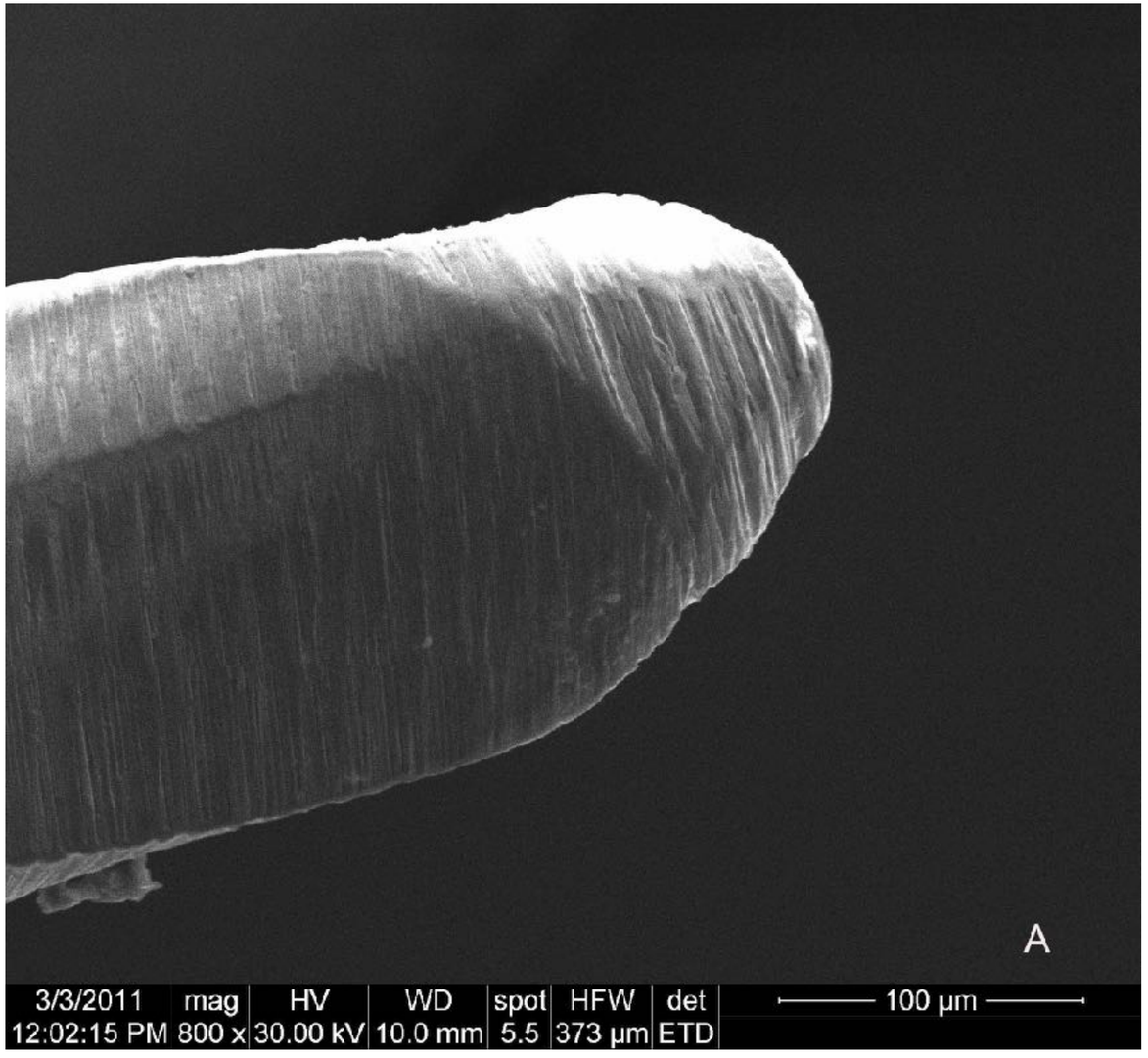
TruNatomy™

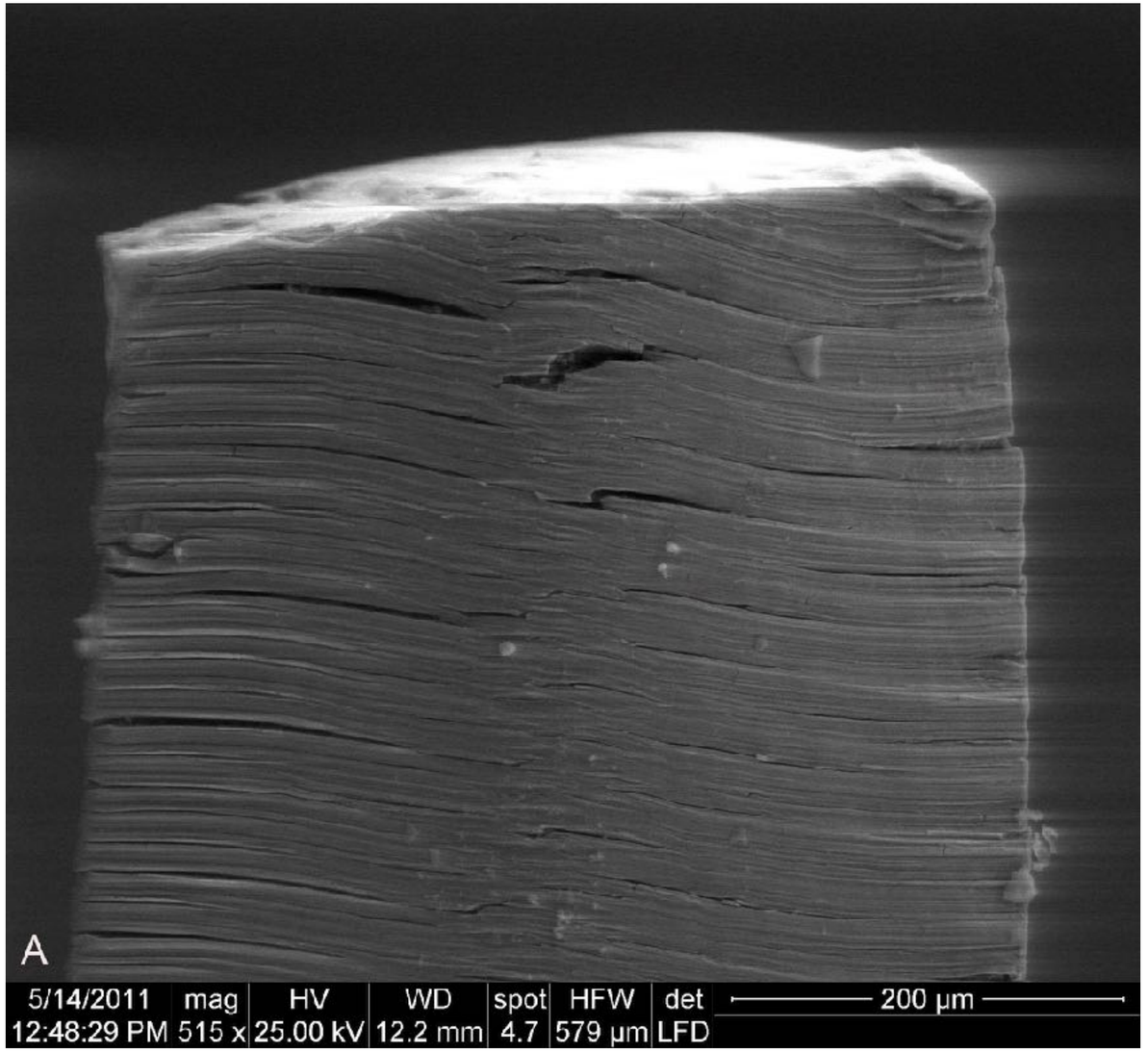


- Af of is around 50°C.
- mainly contain martensite and R-phase under clinical conditions
- Postmachining heat treatment

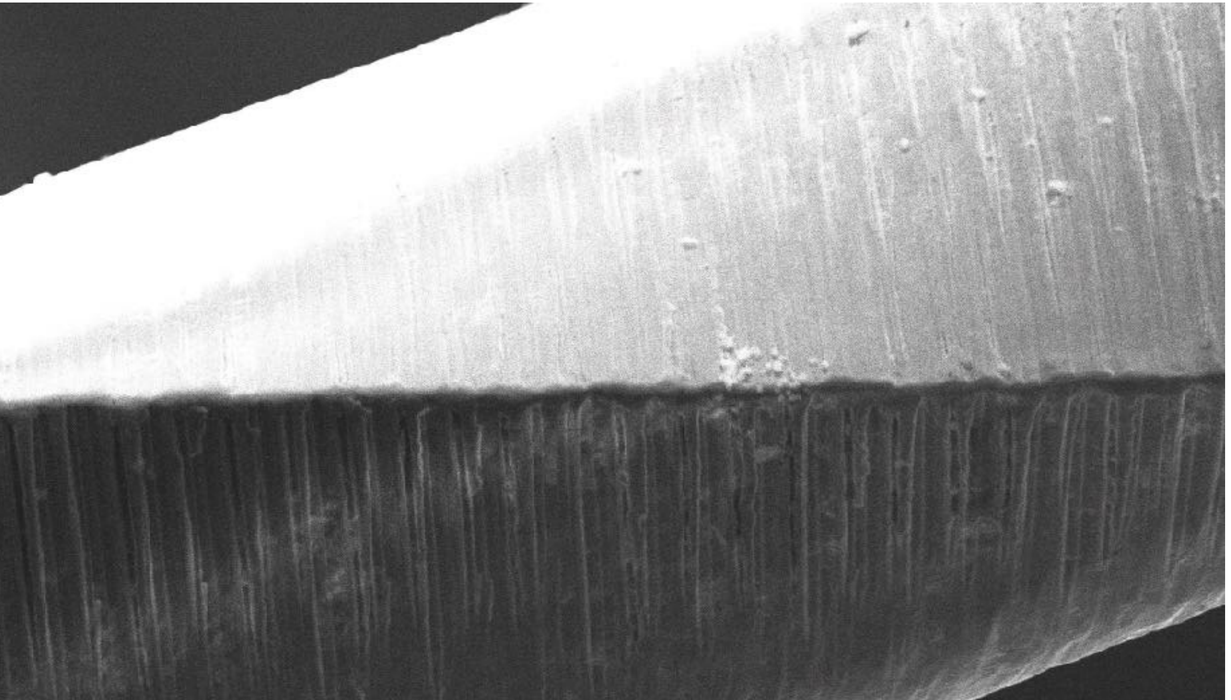


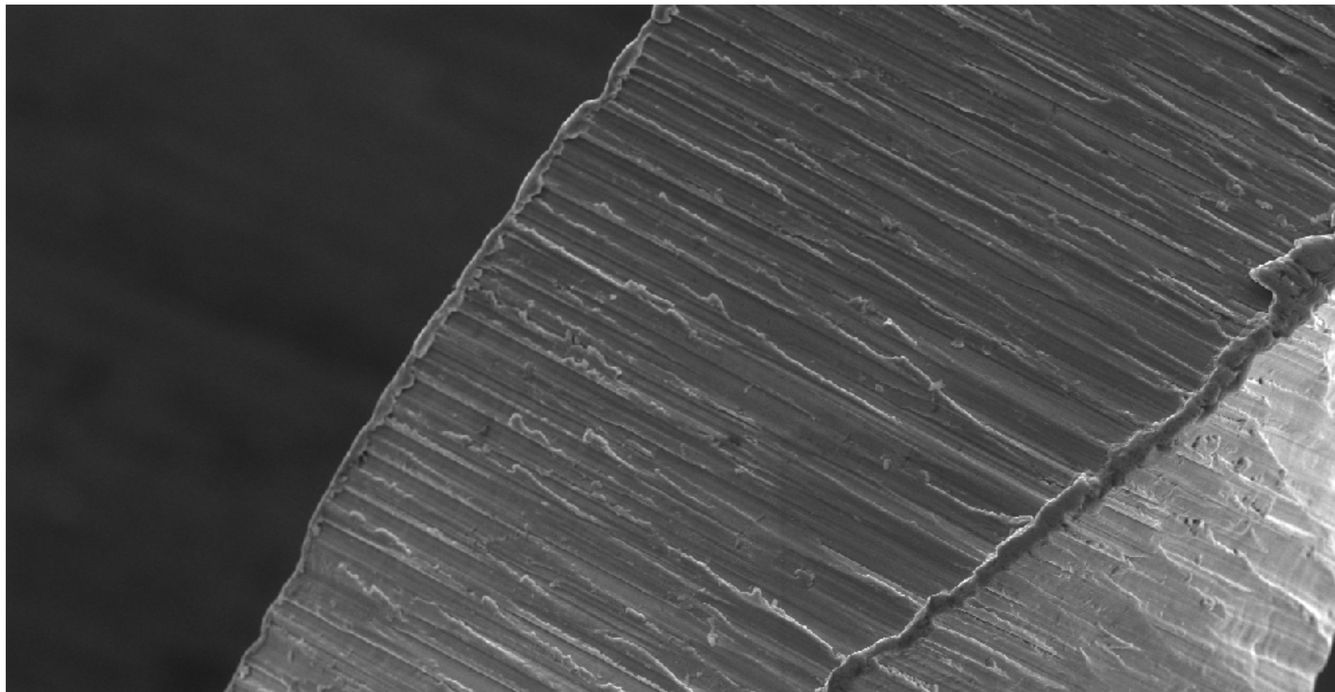
Elkholy 2012





Elkholy 2012





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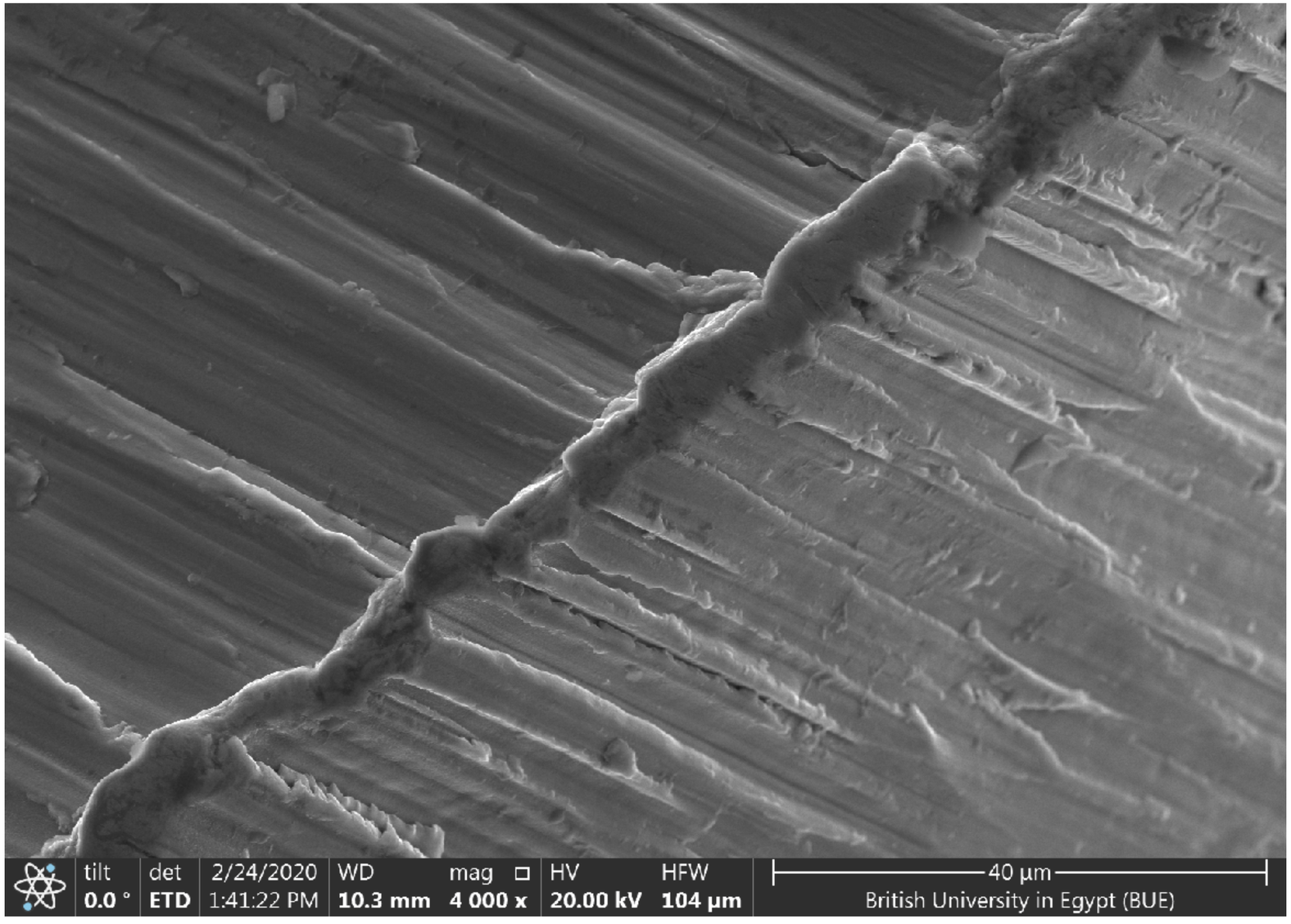
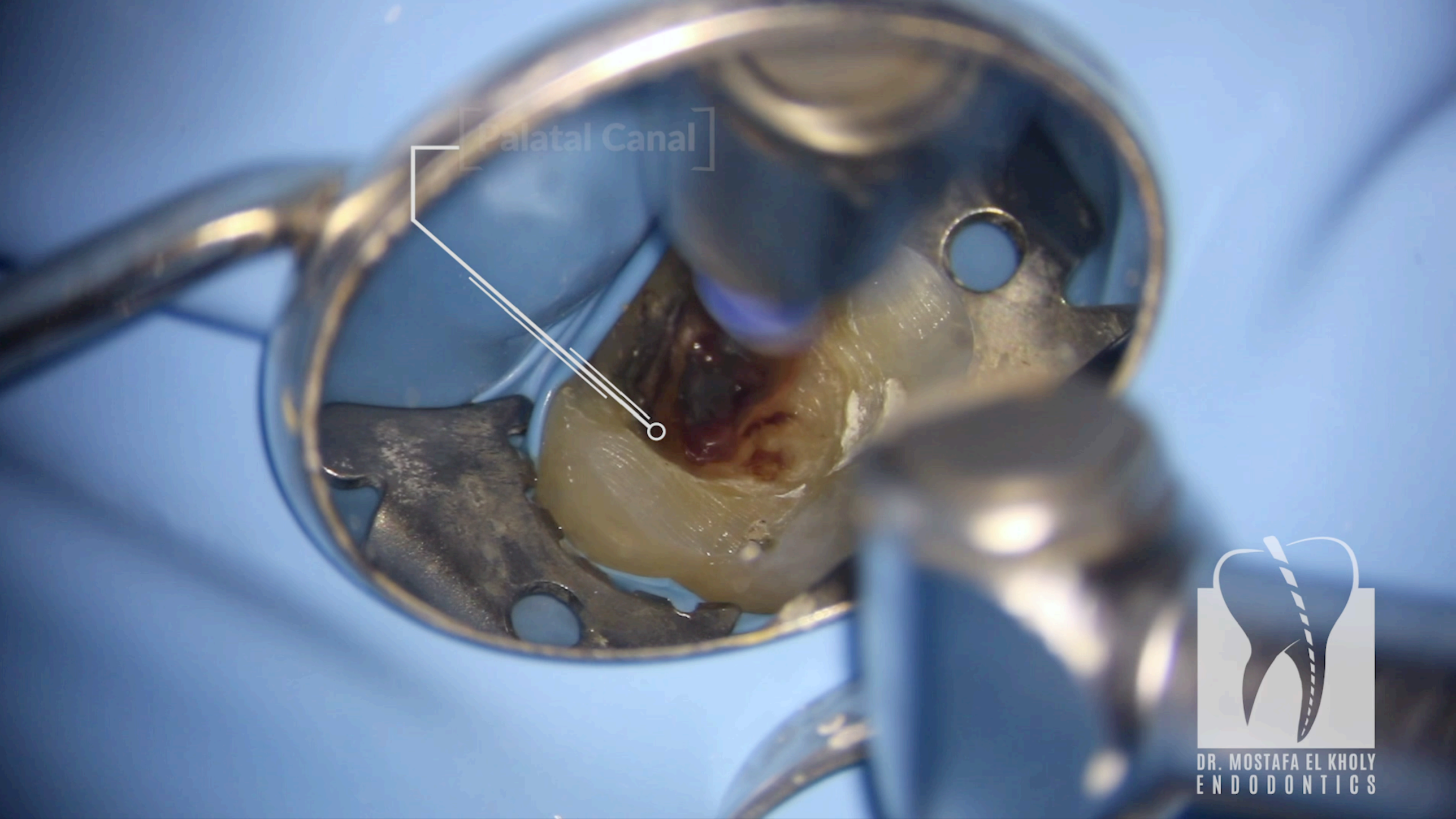

tilt
0.0 °
det
ETD
2/24/2020
1:41:22 PM
WD
10.3 mm
mag
4 000 x
HV
20.00 kV
HFW
104 µm
40 µm
British University in Egypt (BUE)

Enhanced flexibility and fatigue resistance compared with Au NiTi

MaxWire®

- Martensitic (20 °C), austenitic (35 °C)
- Superelastic +shape memory effect

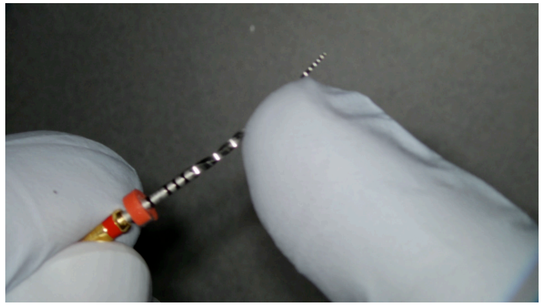

Palatal Canal
DR. MOSTAFA EL KHOLY
ENDODONTICS

Martensitic NiTi

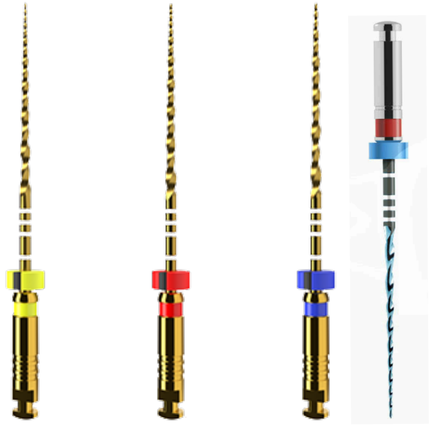
- High cyclic fatigue resistance
- Shape memory
- Lower cutting effeciency
- Lower torque resistance

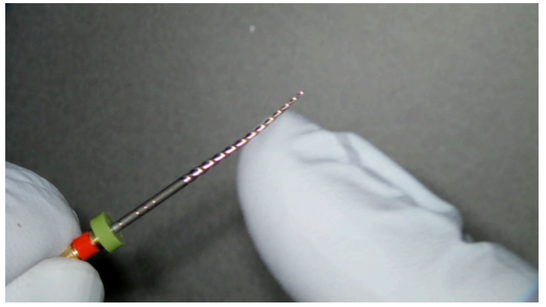
Austenitic

Martensitic

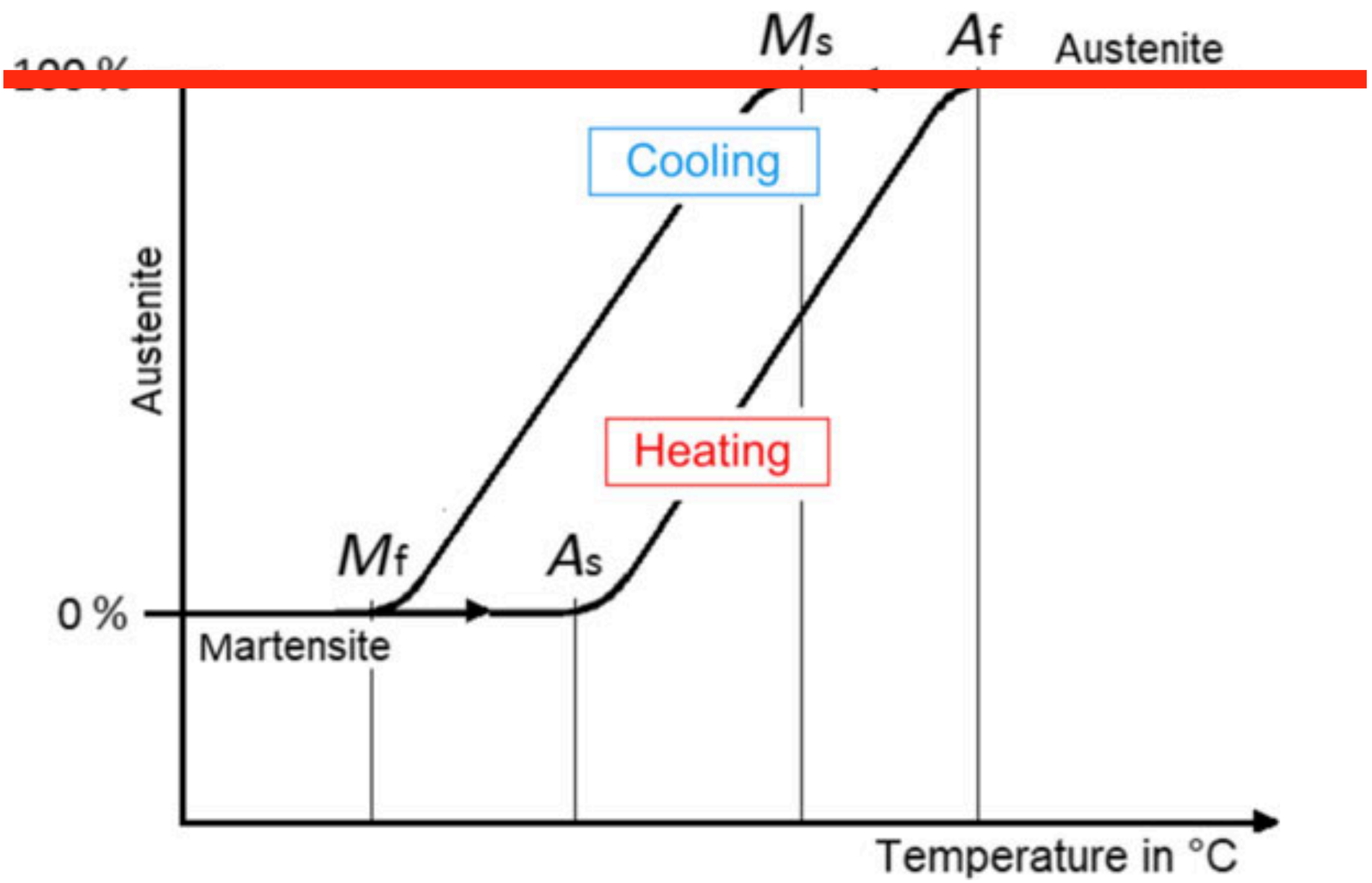


Low cyclic fatigue resistance
Super elastic (Spring back action)
High cutting effeciency
High torque resistance





High cyclic fatigue resistance
Shape memory
Lower cutting effeciency
Lower torque resistance


Ms
Af
Austenite
Cooling
Heating
Austenite
Mf
As
0 %
Martensite
Temperature in °C

Austenitic NiTi

- Conventional
- EP
- M-wire
- R-Phase

Martensitic NiTi

- CM
- Blue
- Gold
- MaxWire

Fourth Group
Change in Kinematics

doi:10.1111/j.1365-2591.2007.01351.x

CLINICAL ARTICLE

Canal preparation using only one Ni-Ti rotary instrument: preliminary observations

G. Yared
102-83 Dawson Road, Guelph, ON N1H 1 B1, Canada

Int Endod J, April 2008

Fourth Group
Change in Kinematics

RECIPROC® blue

WaveOne® Gold

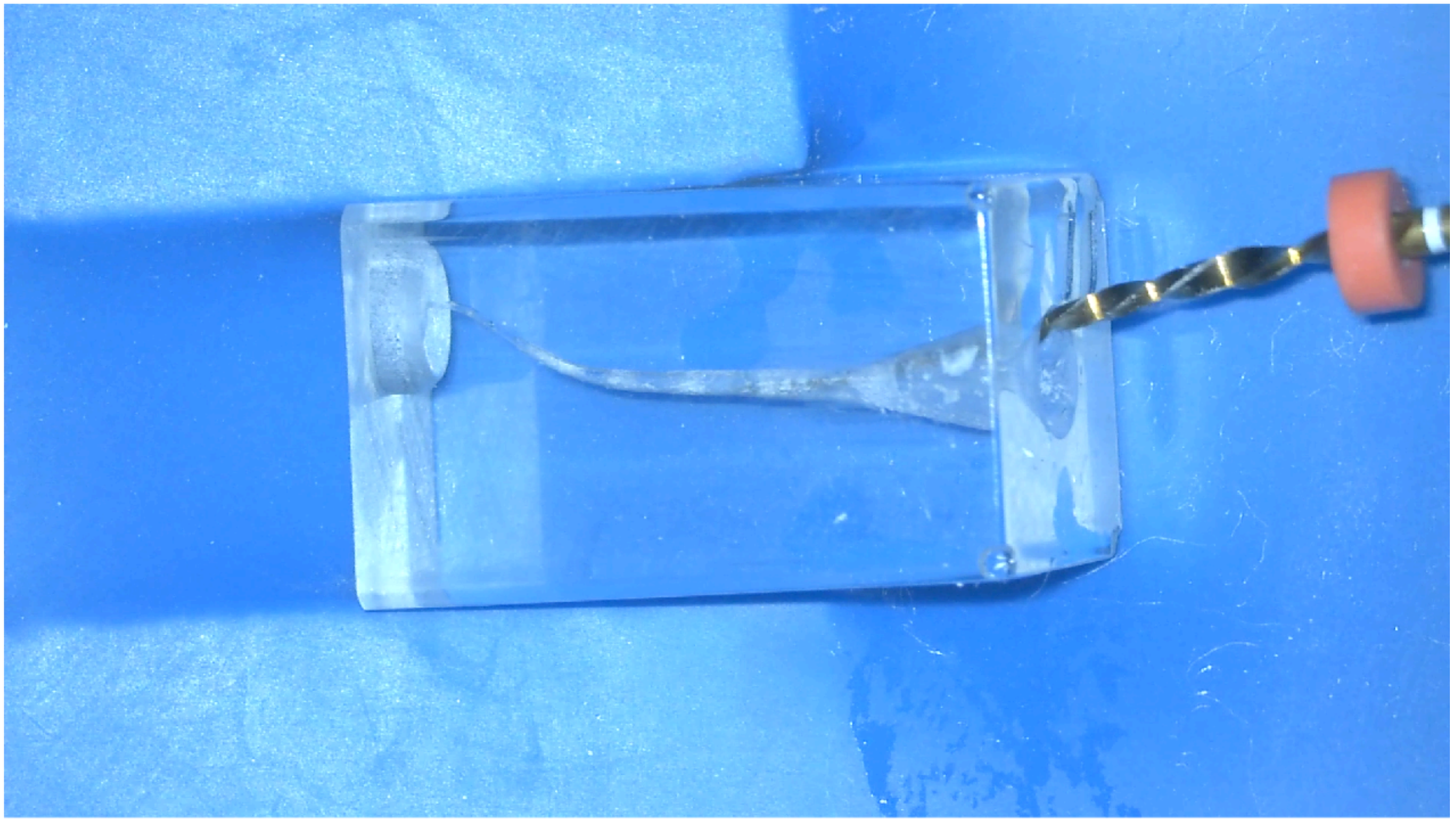
✦Change in Kinematics

Fourth Group
Change in Kinematics

Unequal bidirectional movement

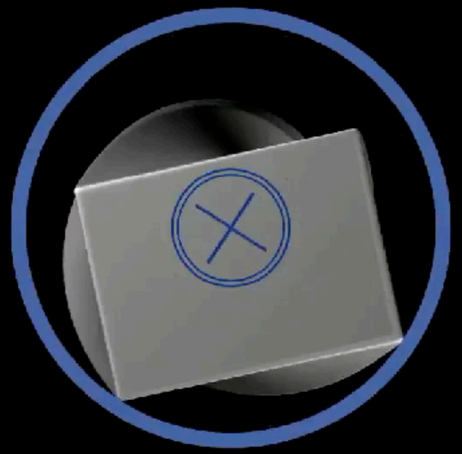
WaveOne® Gold

The Protocol



Shaping

Fifth Group



Change of Rotation Mass

Fifth Group

ProTaper Next®

REVO-S™

MAILLEFER

TruNatomy™

Fifth Group