SWTEST ASIA 2022

Thermal Stability and Properties Of PALYSIUM – Revolutionary Probe Material

Heraeus Precious Metals

Dr. Jonas Fecher
Jonas Sorg

Hsinchu, Taiwan, October 26-28, 2022

Heraeus through the ages

1660
Founding of the Heraeus family business

2022
Fortune 500 company

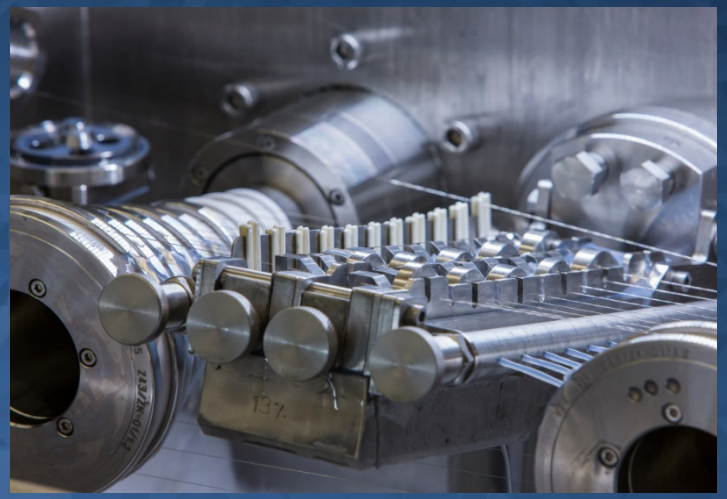
29.5 bn. €
TOTAL REVENUE
in 2021

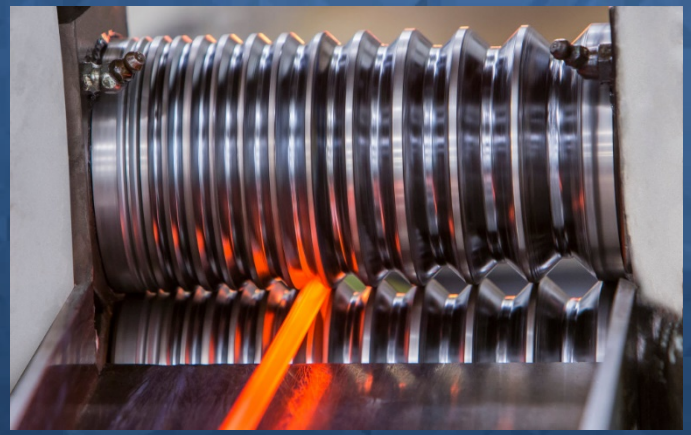
16.000
EMPLOYEES
worldwide

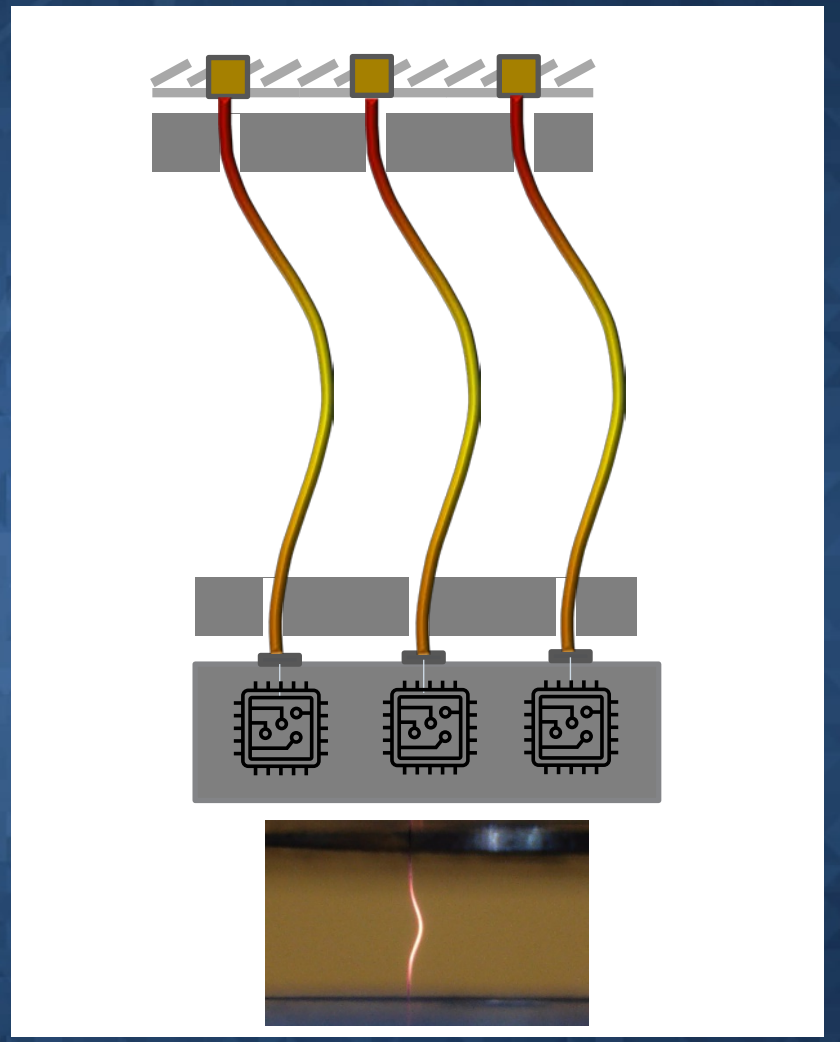
12 market-oriented
GLOBAL BUSINESS UNITS

Palysium production at Heraeus Precious Metals



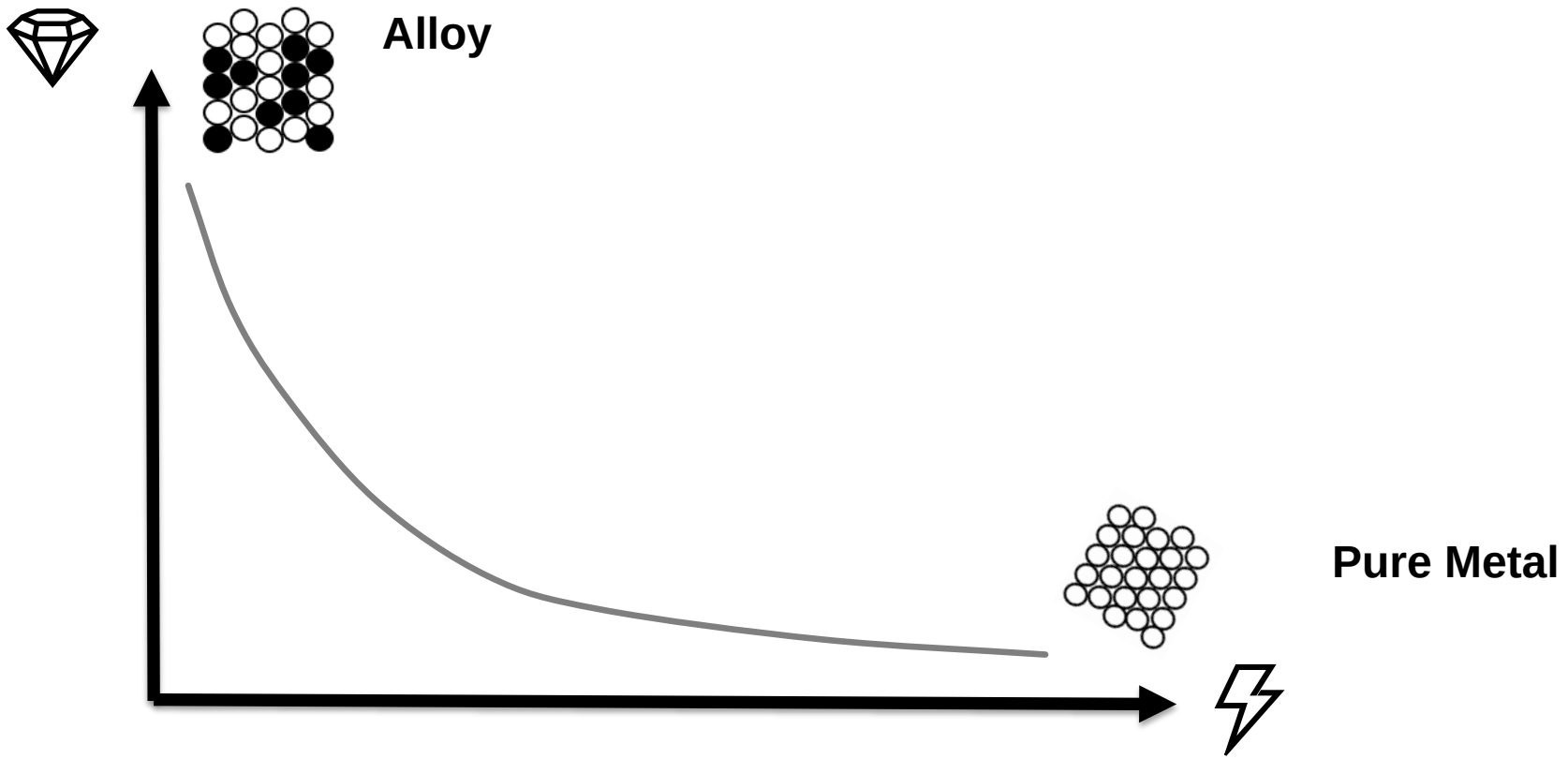




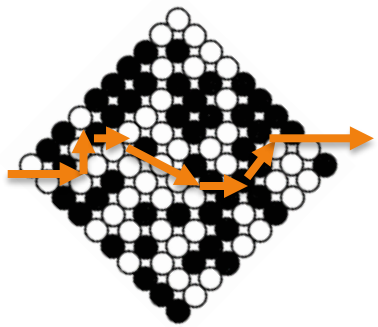



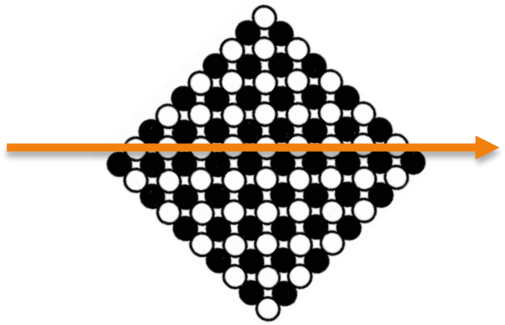
Mechanical and electrical properties (41 µm wire)

	Hera 6321	Palysium
Young‘s modulus	112 GPa	120 GPa
Yield strength	1300 - 1450 MPa	1250 - 1500 MPa
Conductivity IACS	~ 10 %	**> 24 %**

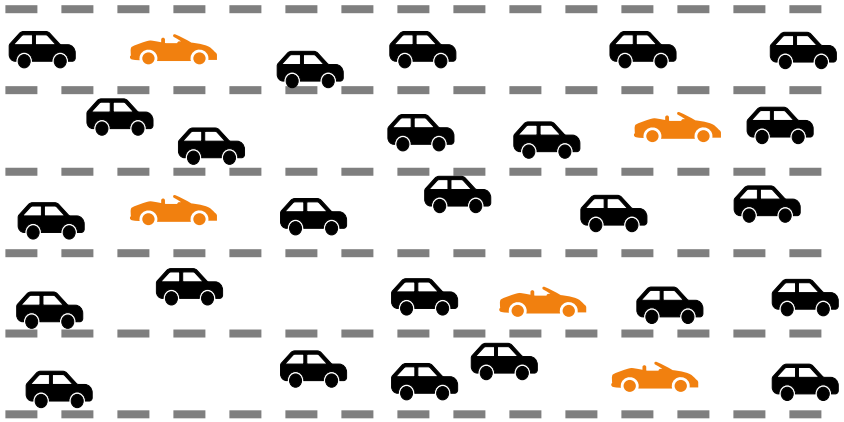

Alloy
Pure Metal

Alloys: random distribution Palysium: ordered superlattice

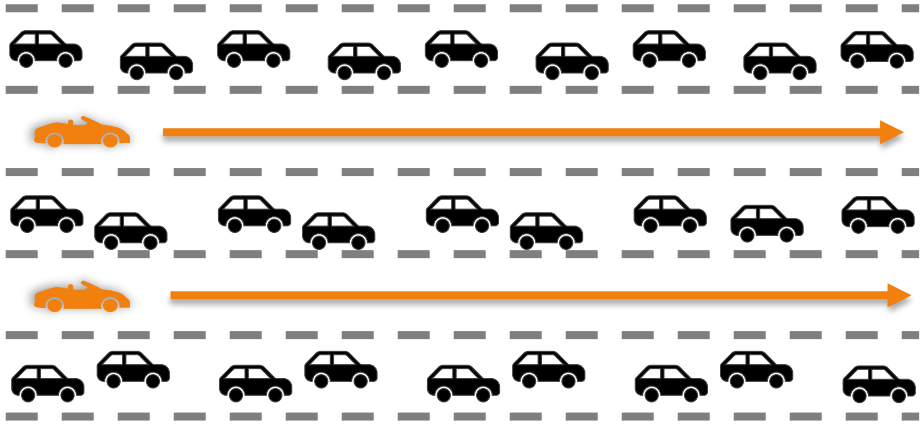


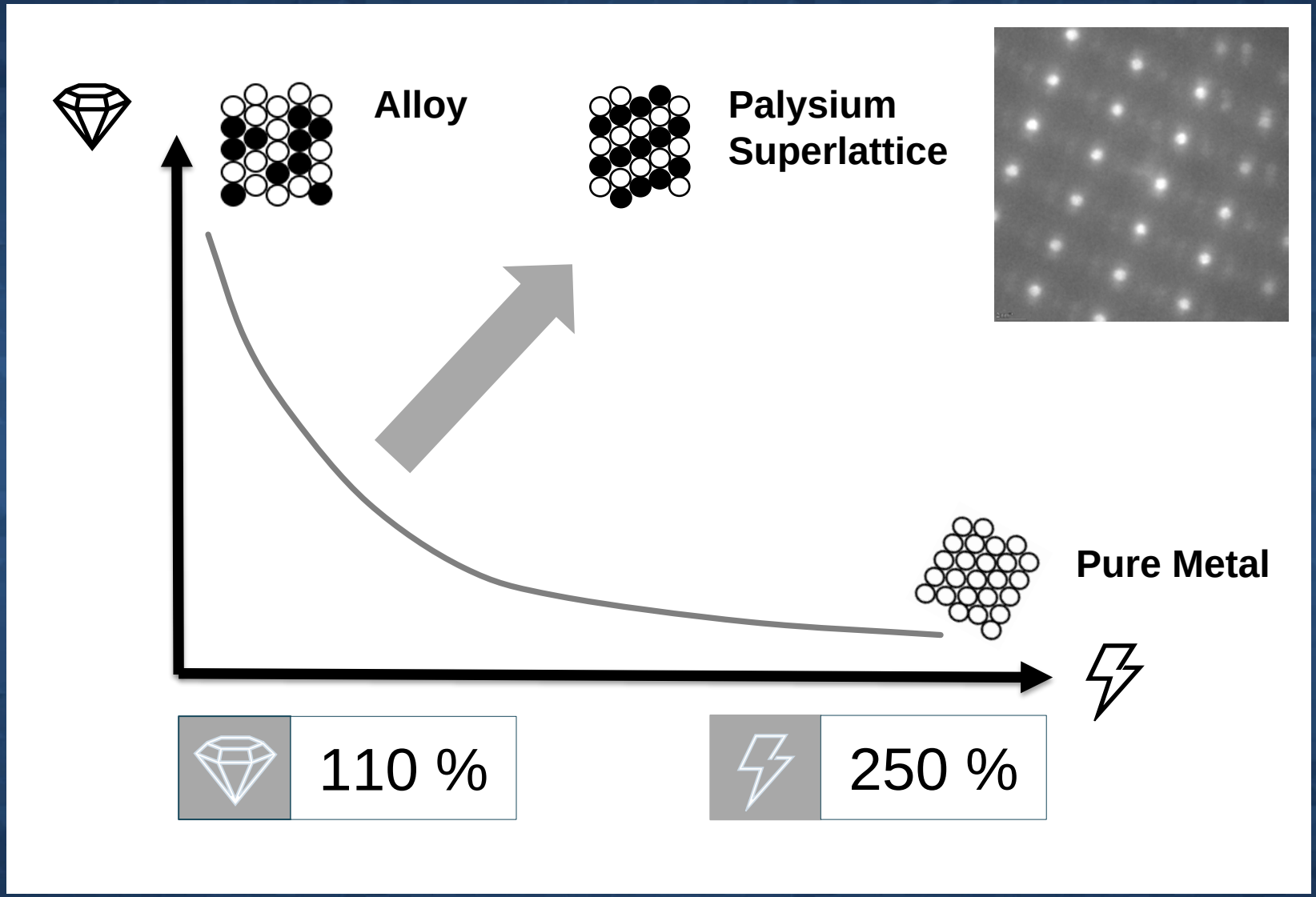


Congested lanes



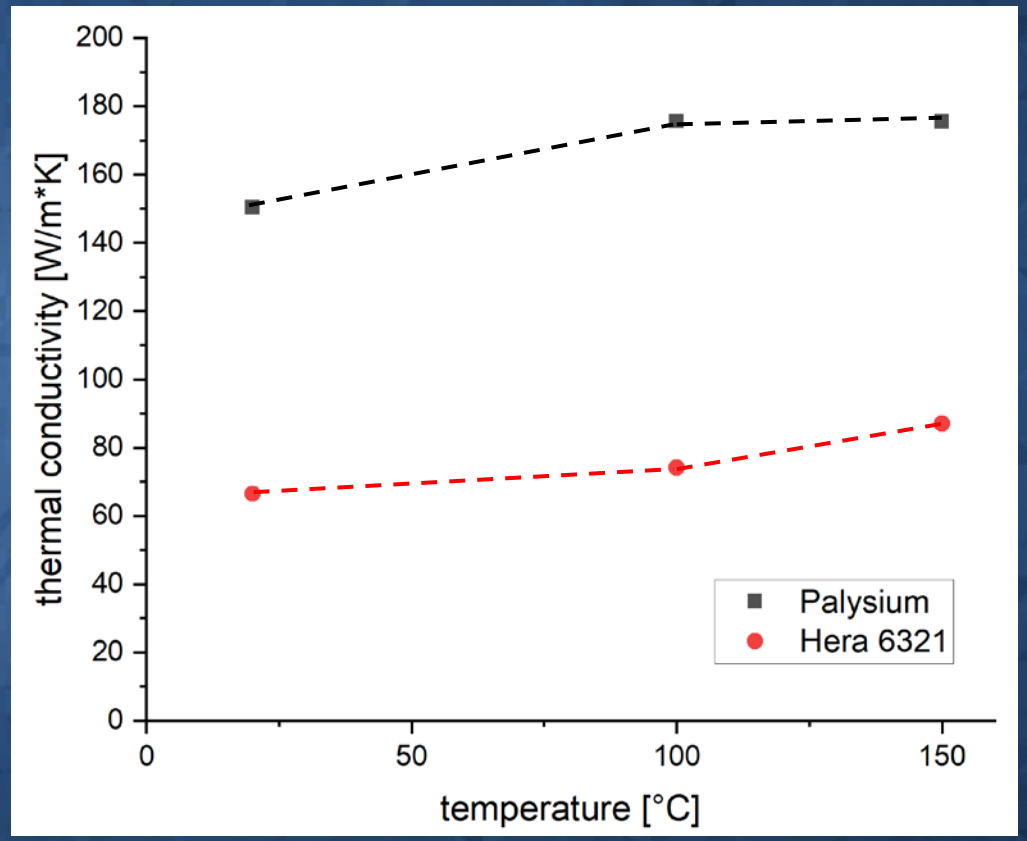
Superlattice „free“-way




Alloy
Palysium
Superlattice
Pure Metal
110 %
250 %

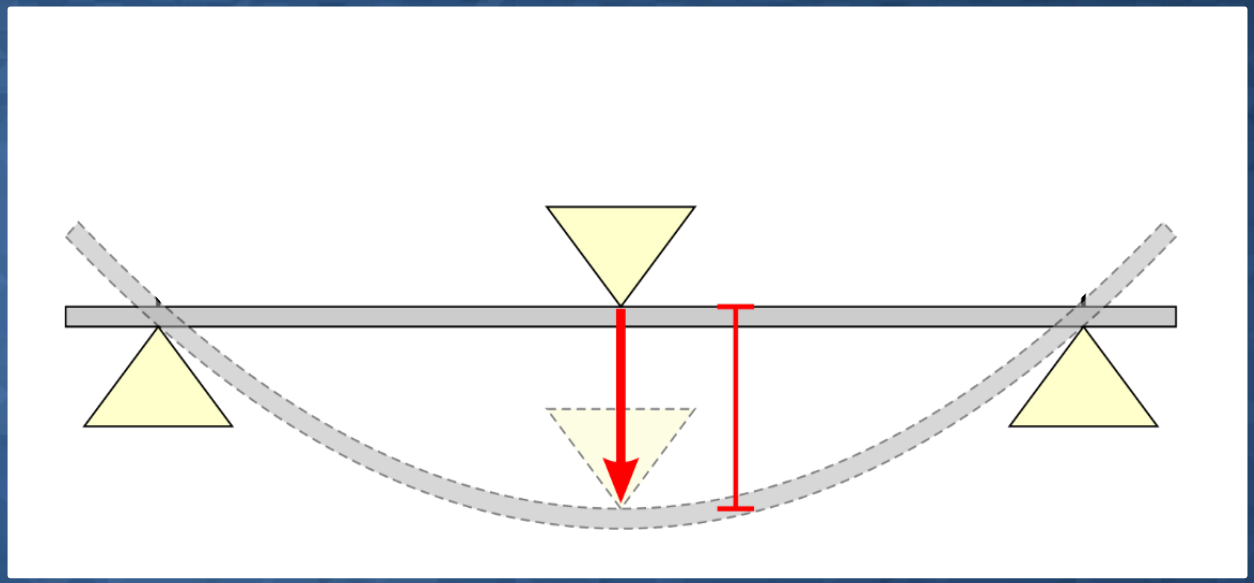
Thermal conductivity

- **Thermal conductivity**
  - > 2x higher thermal conductivity of Palysium vs. 6321
  - Slight increase of conductivity with rising temperature up to 150 °C

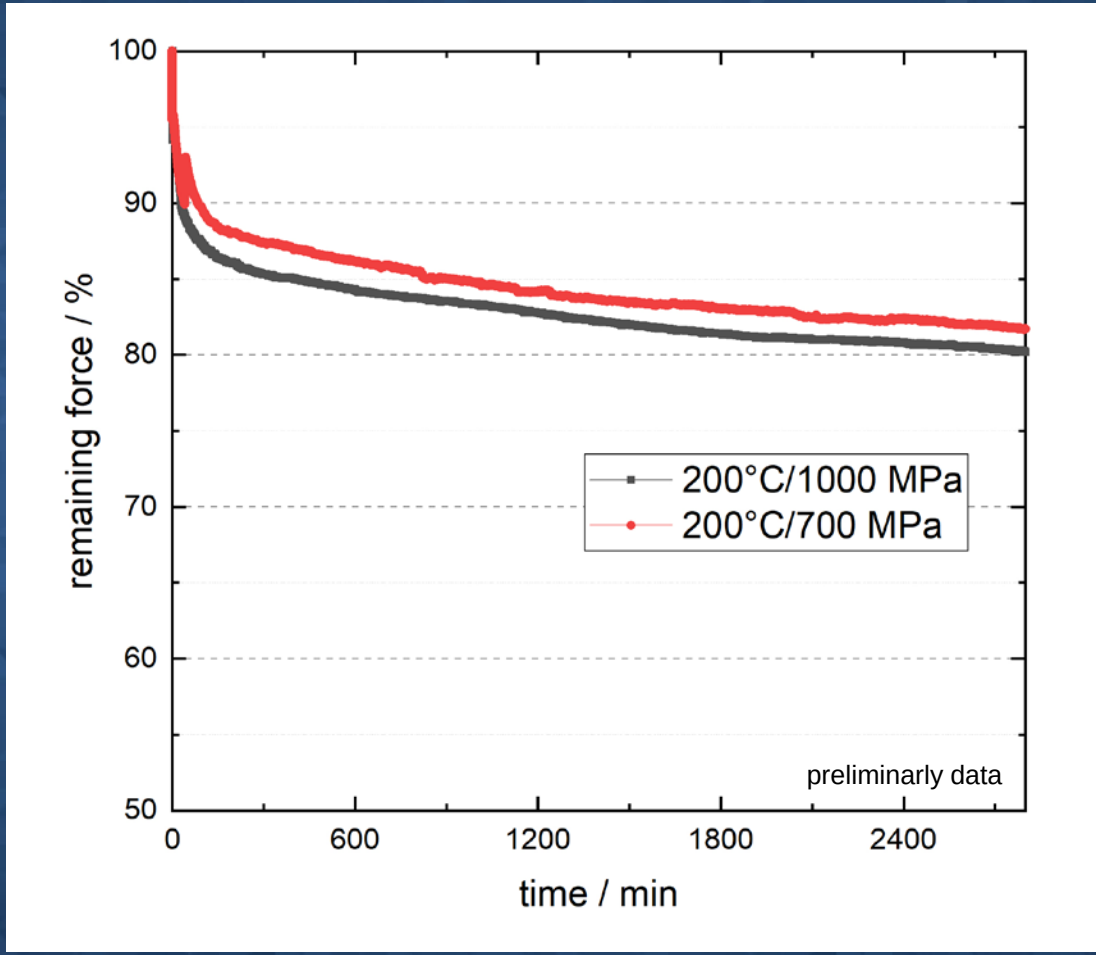


Thermal stability at high temperatures

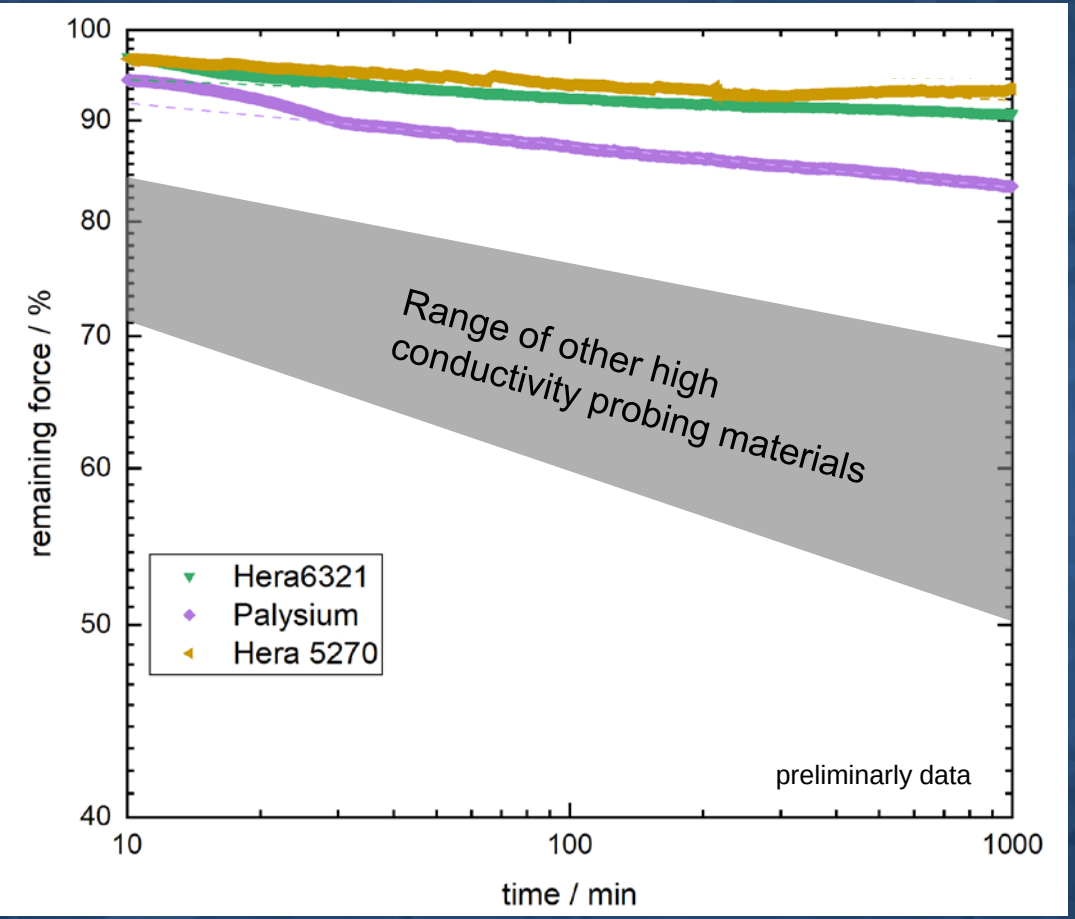
- **General setup**
  - 3-point bending setup
  - Deflection is applied and kept constant over time
  - 200 °C / Outside fiber tension 700MPa + 1000 MPa
  - Force reduction is measured over time
  - Relaxation not creep



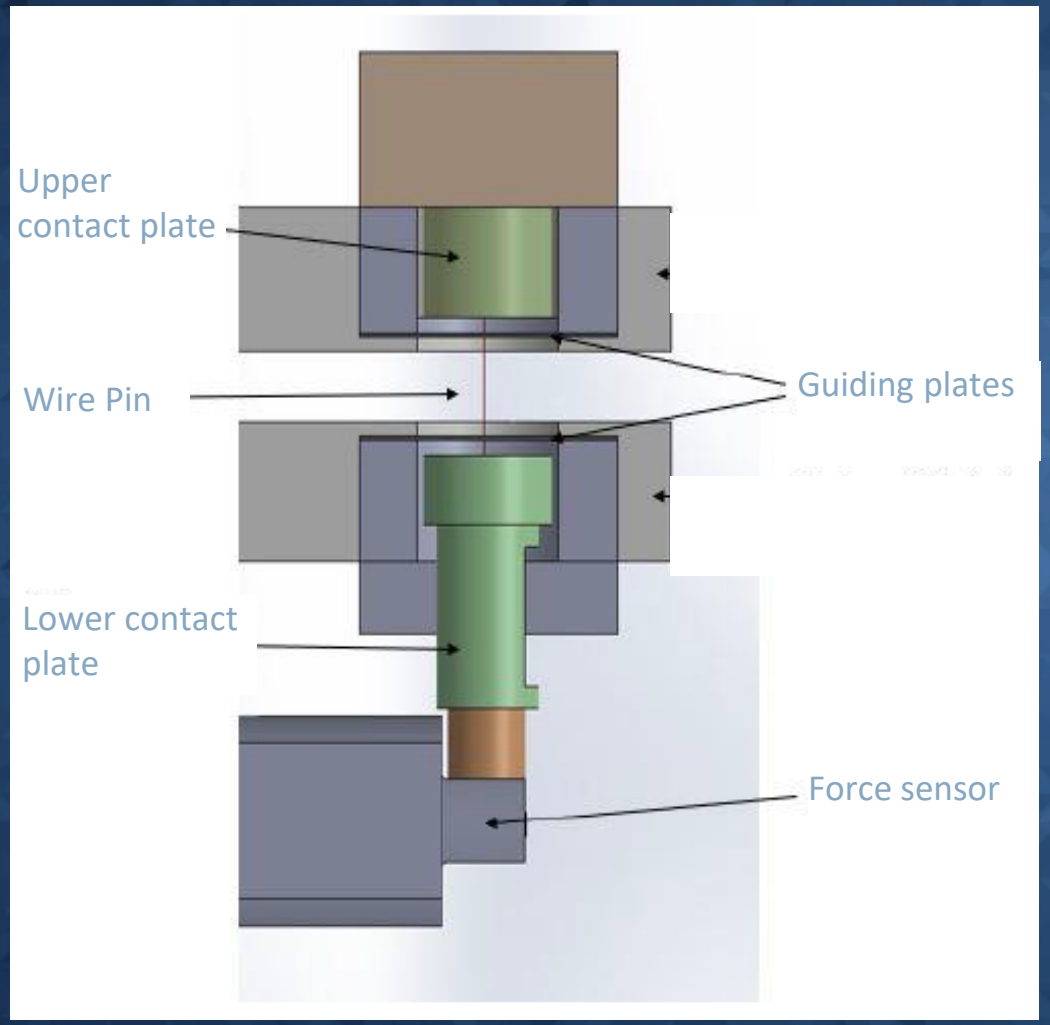
Thermal stability at high temperatures



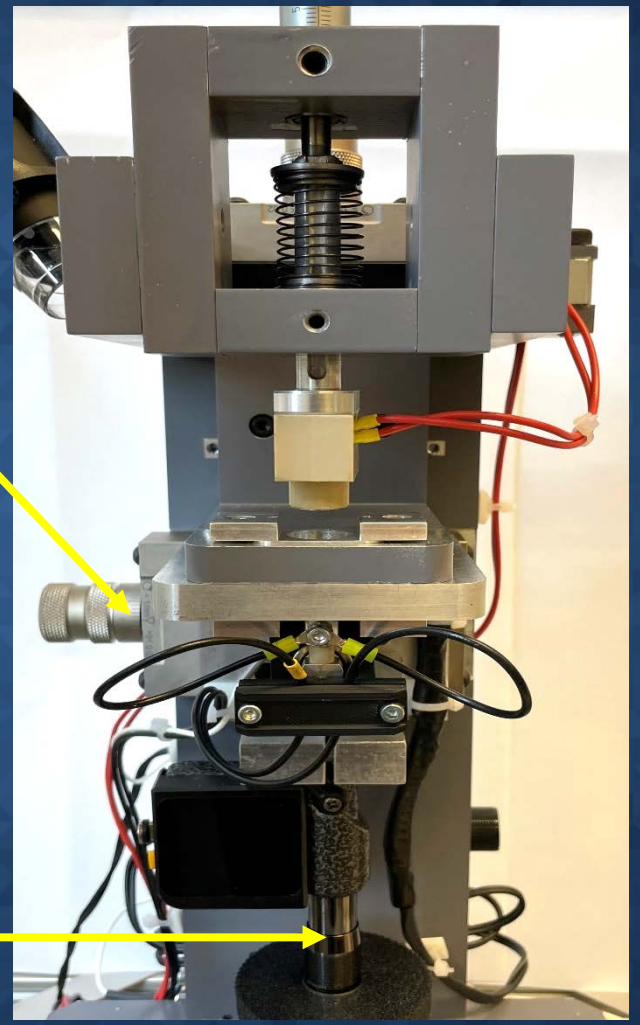
Thermal stability at high temperatures



CCC / MAC Measurement

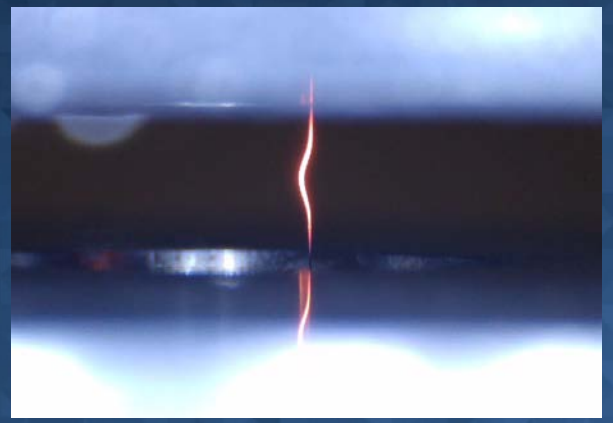


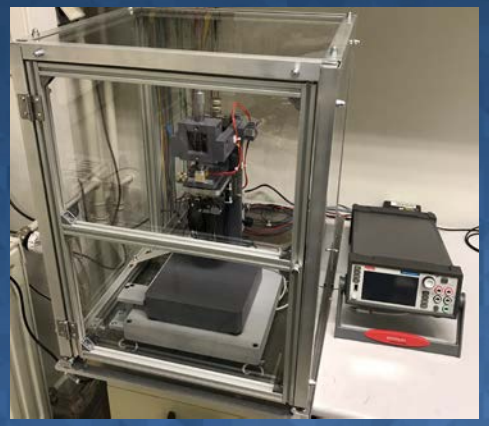
X-axis offset adjustment of lower guiding plate



Overtravel adjustment and z-measurement

How hot?

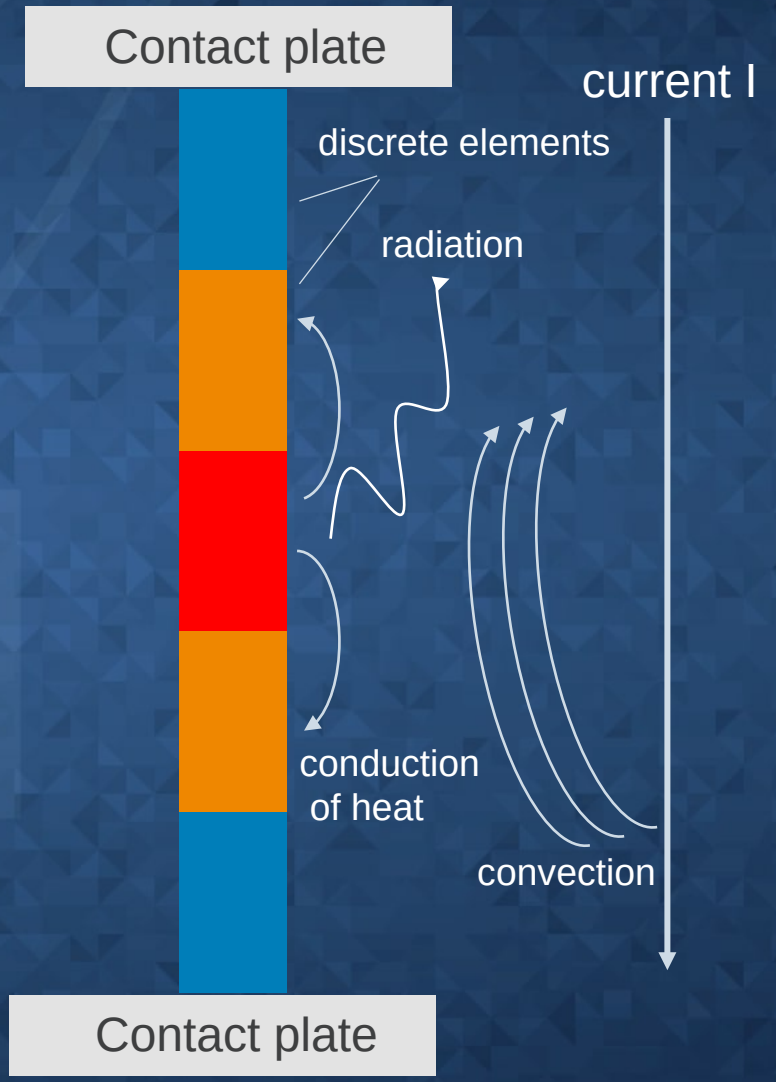




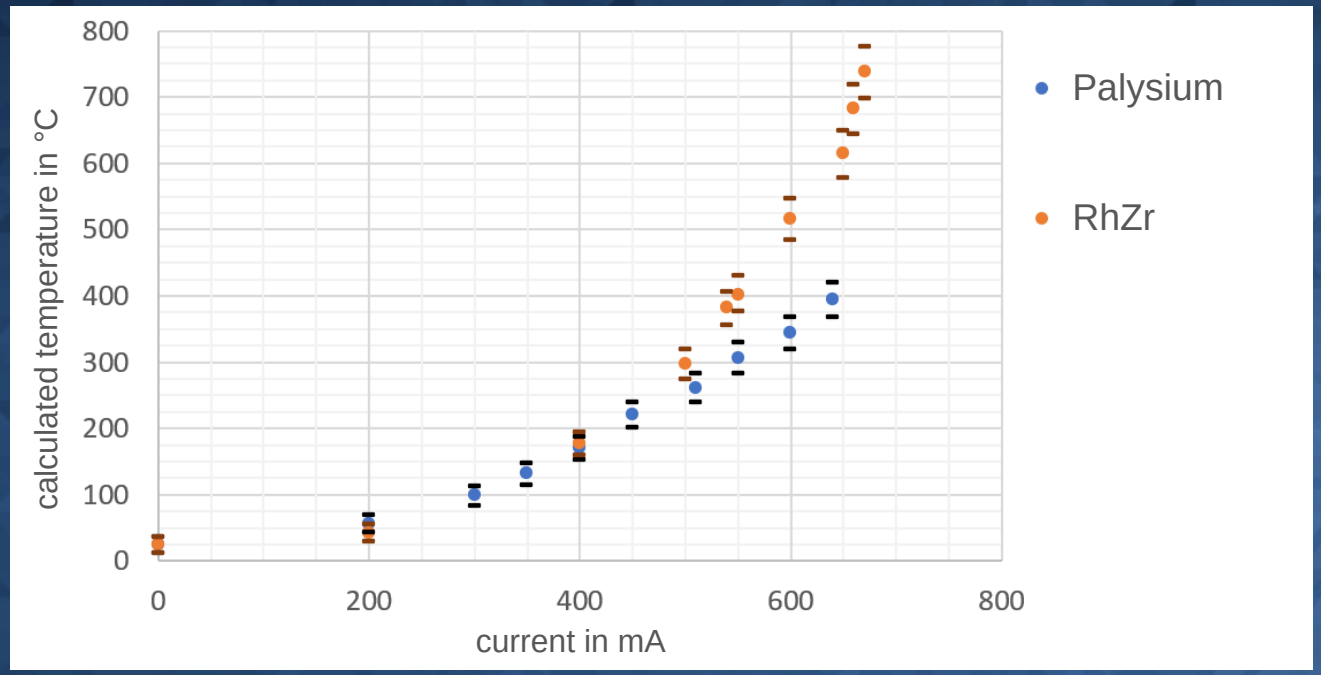
- **Resistance heating of needle**

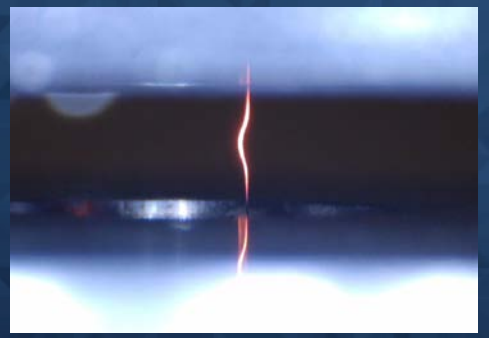
  (Total resistance = Contact resistance + resistivity)

- **Thermal radiation**
- **Conduction of heat**
- **Convection (unknown as not in vacuum)**

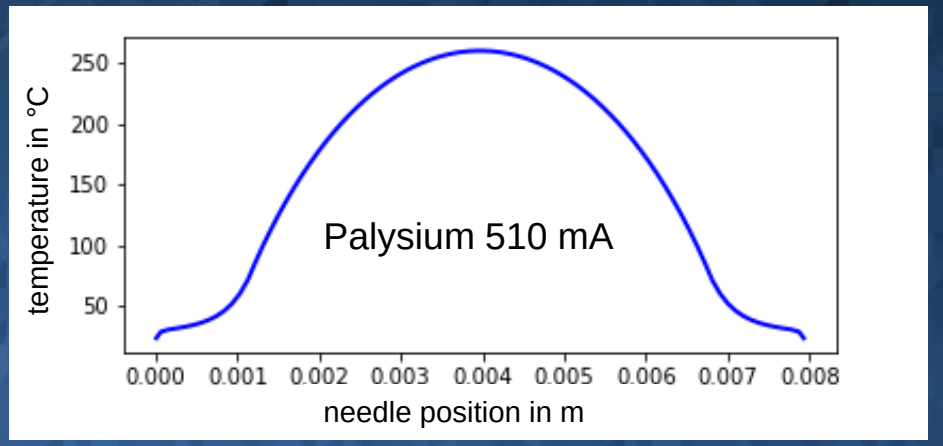


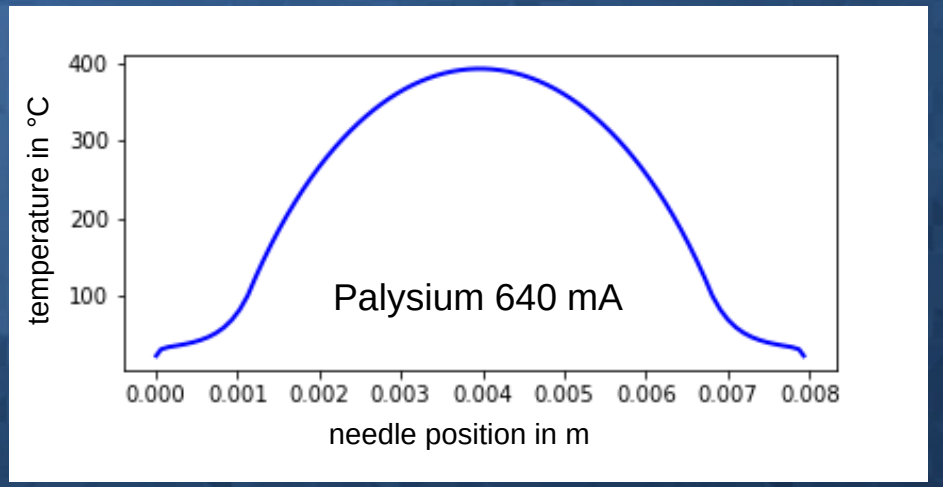
How hot?





680 mA through
41 µm RhZr needle



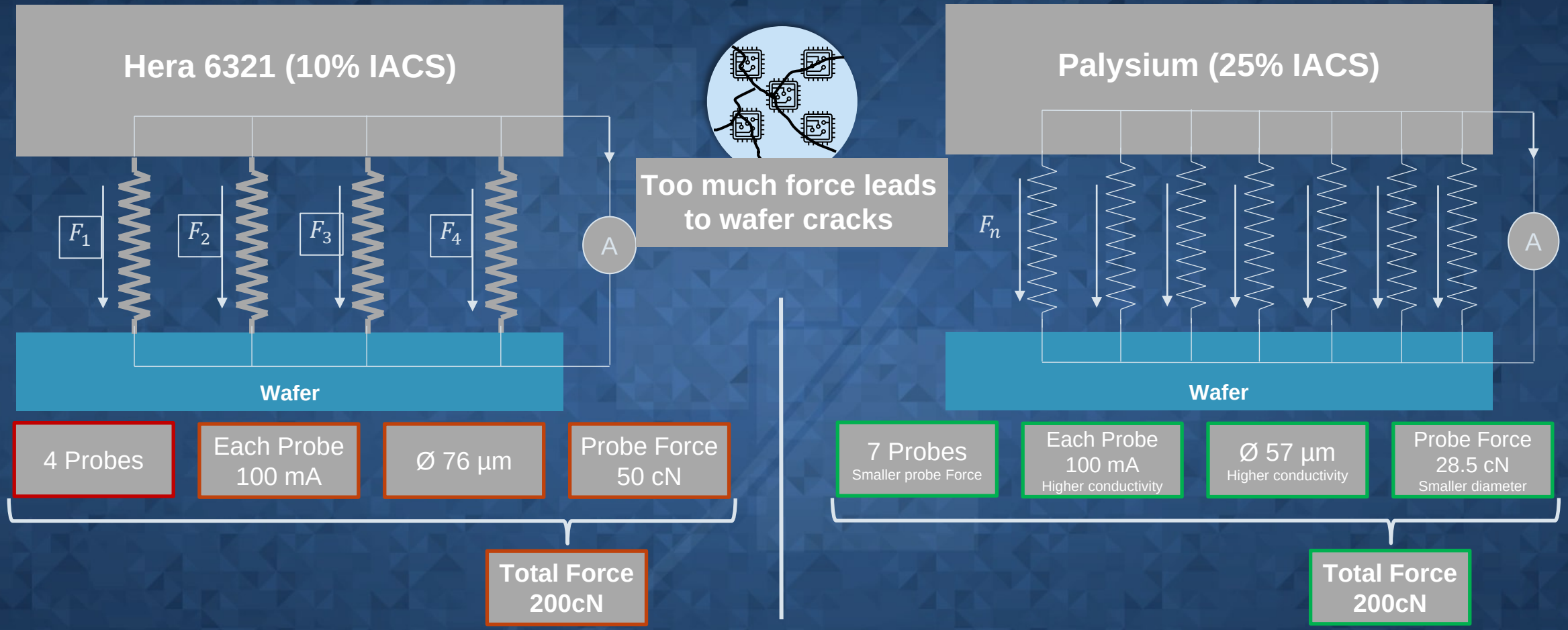


Properties of Palysium compared to Hera 6321 (41 µm wire)

	Hera 6321	Palysium
CCC	380 mA	590 mA **+ 55 %**
MAC	290 mA	506 mA **+ 75 %**
Young‘s modulus	112 GPa	120 GPa
Yield strength	1300 - 1450 MPa	1250 - 1500 MPa
Conductivity IACS	~ 10 %	> 25 % **+ 150 %**
Thermal conductivity	66 W/mK	150 W/mK **+ 130 %**

Green values represent improvement vs. Hera 6321

Palysium Benefit – Same Force with increased Pin Number (Theoretical Example)



Same total force, same current per pin but 75% higher pin count. Smaller pitch possible

Conclusion

- Heraeus has developed a material with 2.5 x higher conductivity
- High thermal conductivity
- Outstanding relaxation behavior
- 55% better CCC
- 75% better MAC
- Higher pin count and faster probing possible
- Higher current with same diameter possible

Thank you!