

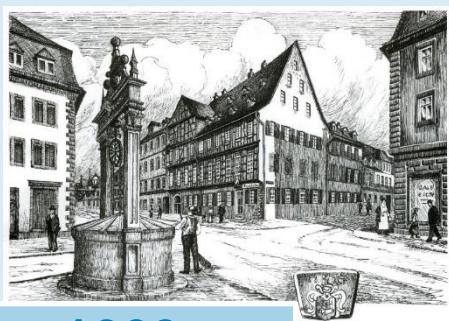
Pt Products for industrial applications @IPMI

Thomas Stenger, Nov 2019



HERAEUS THROUGH THE AGES

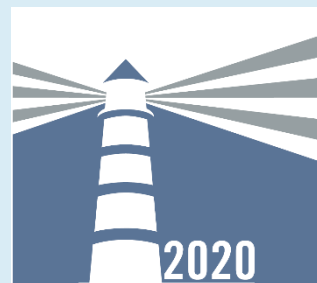
In 1851 Wilhelm Carl Heraeus takes over his father's pharmacy in Hanau's market square. He uses the oxyhydrogen gas method to smelt **platinum** for the first time ever. This forms the foundation for the industrial processing of precious metals.



1660
Founding of the
Heraeus Pharmacy



1851
Founding of the
Heraeus Company



2020
Vision 2020

2060
400th anniversary of the
family business

HERAEUS – A GLOBALLY SUCCESSFUL PORTFOLIO COMPANY

TOTAL REVENUE
 **€ 20.3 bn**

 **7%** R&D
 EXPENDITURES¹

Market-oriented distribution
 in **11** GLOBAL
 BUSINESS
 UNITS

Listed in
 **FORTUNE**
 GLOBAL **500**

TOP 10 FAMILY-
 OWNED COMPANIES
 in Germany

REVENUE EXCL. PRECIOUS METALS

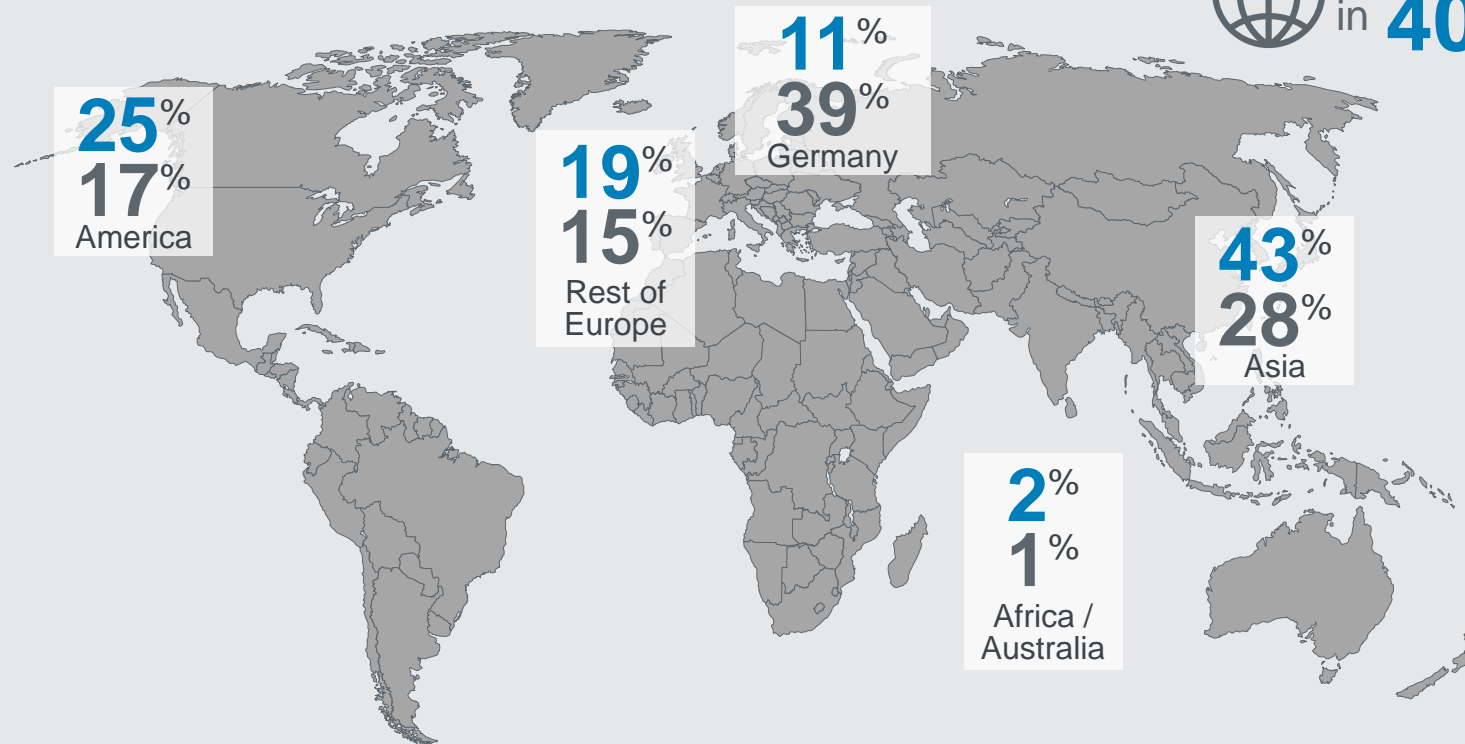
2018 BY REGION

EMPLOYEES

2018 BY REGION

EMPLOYEES²
 **14,900**

More than **100**
 **SITES**
 in **40** COUNTRIES



¹ based on revenues excl. Precious Metals

² incl. contract employees

PLATINUM



When pure, the metal appears greyish-white and firm. The metal is **corrosion-resistant**. The **catalytic properties** of the six platinum family metals are outstanding. For this catalytic property, platinum is used in catalytic converters, incorporated in **automobile exhaust systems**, as well as tips of **spark plugs**.

Platinum's wear- and tarnish-resistance characteristics are well suited for **making fine jewellery**. Platinum is more precious than gold. The price of platinum changes along with its availability, but its price is normally slightly less than 150% of the price of gold. In the 18th century, platinum's rarity made King Louis XV of France declare it the **only metal fit for a king**.

Platinum possesses **high resistance to chemical attack**, **excellent high-temperature characteristics**, and **stable electrical properties**. All these properties have been exploited for **industrial applications**. Platinum **does not oxidize** in air at any temperature, but can be corroded by cyanides, halogens, sulfur, and caustic alkalis. [1]

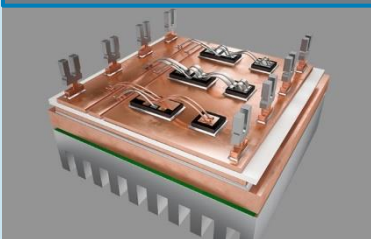
PLATINUM IS A KEY MATERIAL IN 5 BUSINESS UNITS

GLOBAL BUSINESS UNITS

Heraeus
Precious Metals



Heraeus
Electronics



Heraeus
Nexensos



Heraeus
Epurio



Heraeus
Medical



Heraeus
Medical Components



Heraeus
Conamic



Heraeus
Comvance



Heraeus
Noblelight



Heraeus
Electro-Nite



Heraeus
Photovoltaics



HERAEUS WORLD OF PLATINUM PRODUCTS

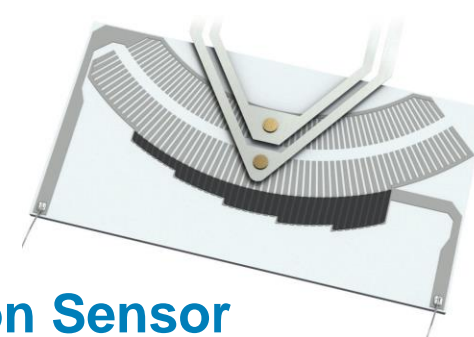


Temperature Sensor

Pt conductor paste

Pacemaker Electrode

Formed out of PtIr



Position Sensor

AuPtPd Thick Film technology



Emission Catalyst

Pt coated

Anti-cancer hAPIs

Cis- /Carbo- / Oxaliplatin



Tools for glass making

Stirrer made of Pt



Precious metals

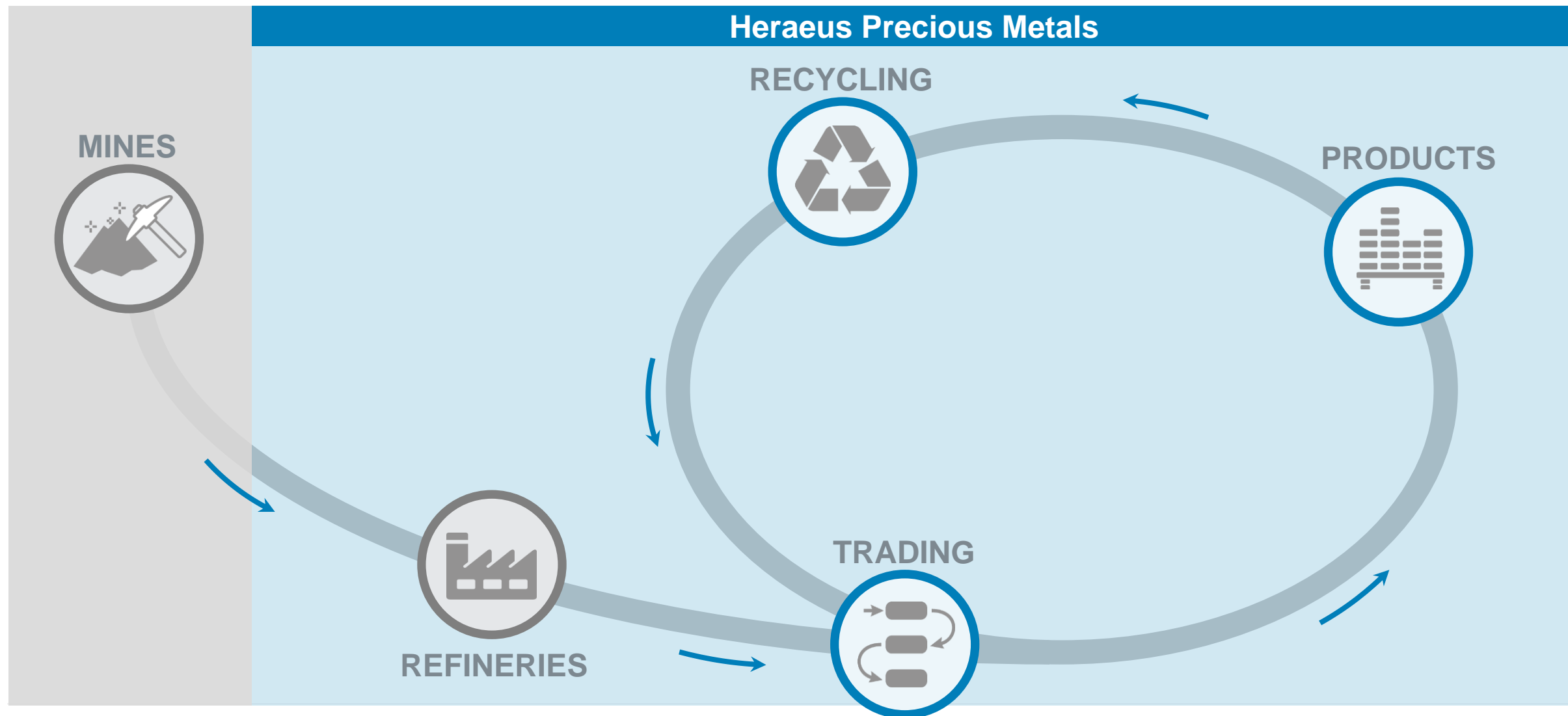
trading, recycling,
industrial processing



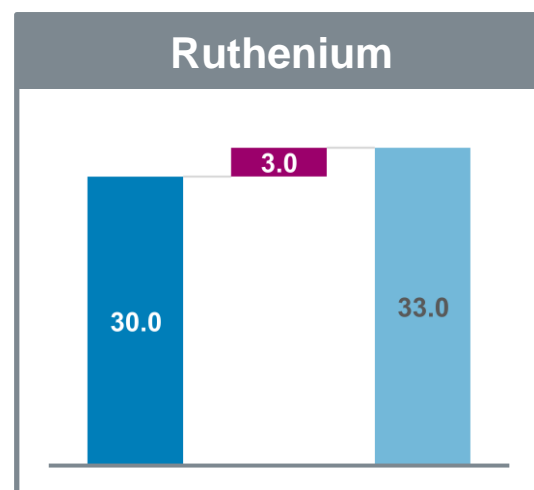
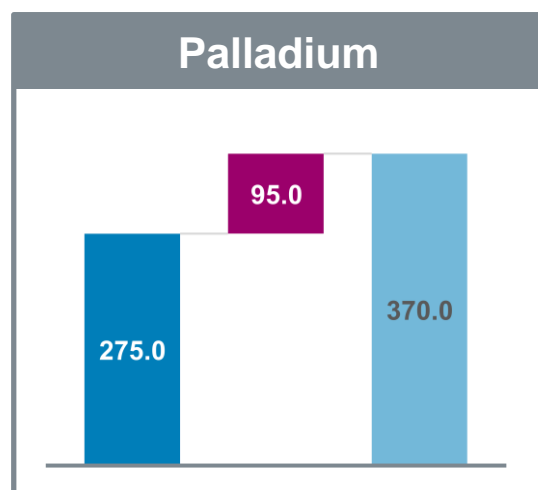
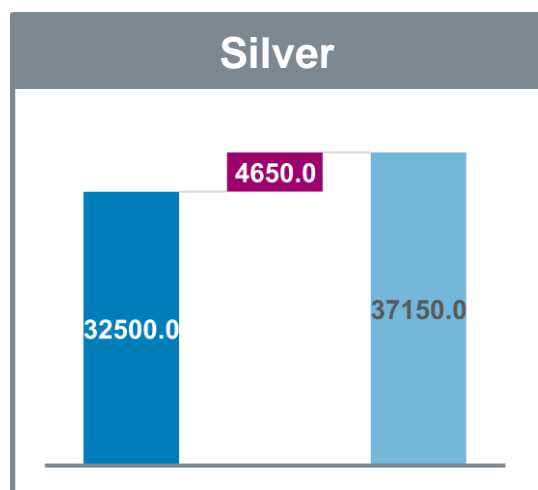
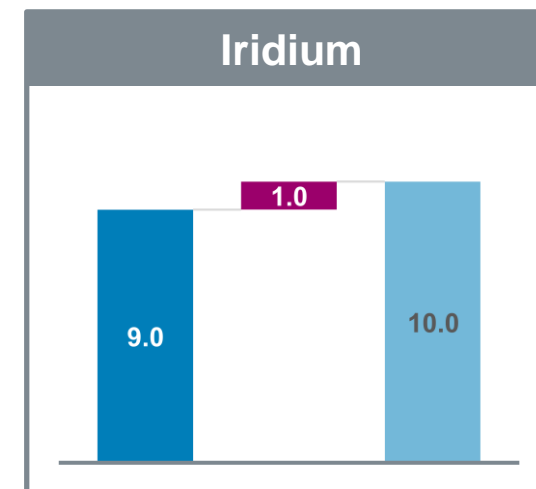
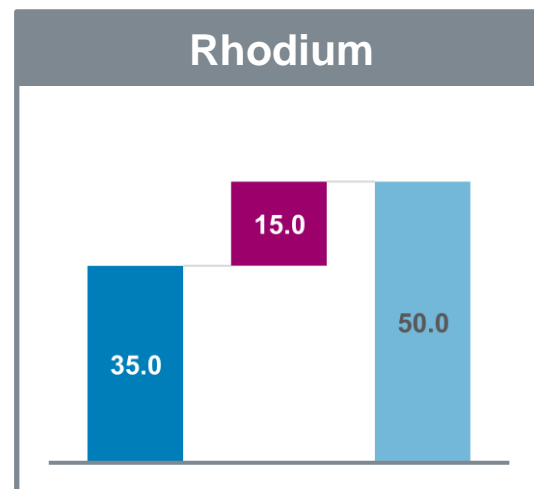
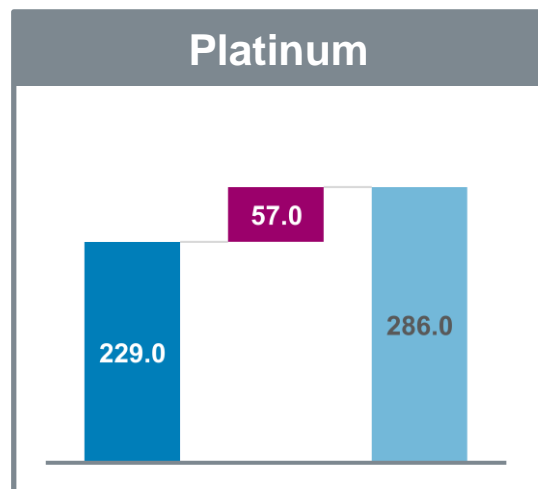
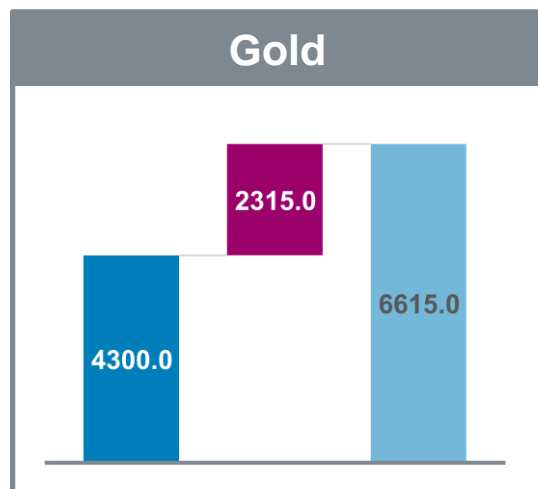
Sensors

for measurements in
molten metal processes:
Pt Thermocouple wire

PLATINUM IN THE PRECIOUS METAL LOOP



RECYCLING HAS BECOME INDISPENSABLE TO COVER GLOBAL PM DEMAND

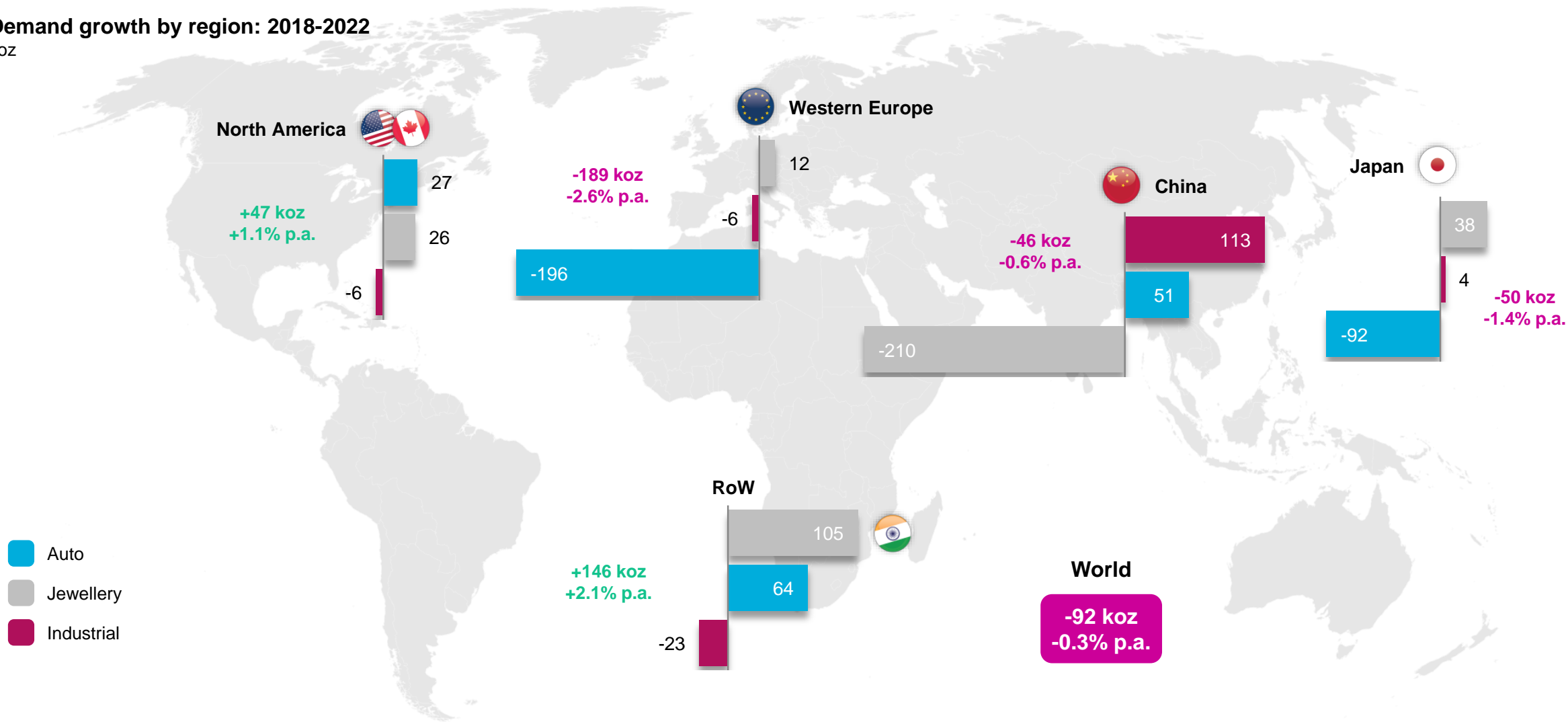


- › Mine supply is not able to entirely cover the demand for PM
- › Recycling has become indispensable: ca. 20% of the global supply of PMs stems from recycling

W. EUROPE (DIESEL) & CHINA (JEWELLERY) DENTING PLATINUM DEMAND

Demand growth by region: 2018-2022

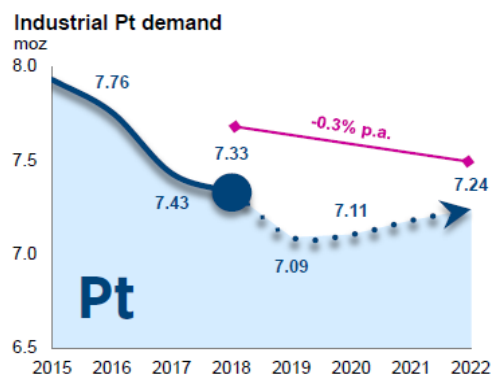
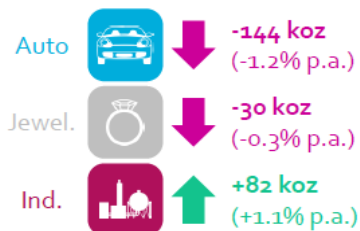
koz



PLATINUM

DEMAND

Pt ↓ -92 koz to 7.24 moz in 2022 (-0.3% p.a.)



Platinum further losing ground in Automarket – Investors temporarily boost price level

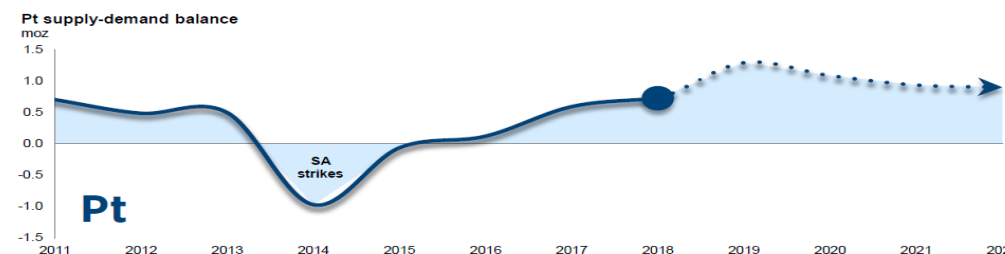
- Demand is on a **continued softening ride** throughout 2019:
- With **jewelry** demand especially from key markets like China dropping further by 13%,
- With **automotive demand** estimated to **drop** by approx. **4% to 2.8 moz**,
- With **non-autocatalyst industrial demand** to **remain flat** year-on-year



SUPPLY

Supply-demand summary

Platinum surplus building (excl. investment)



Peak market oversupply expected this year

- Combination of **growing primary (+5.1%) and secondary (+5.7%) supply** as well as **rather flat year-on-year demand** is **widening the fundamental market surplus** from 725 koz in 2018 to an estimated 1.29 moz in 2019.

HERAEUS WORLD OF PLATINUM PRODUCTS

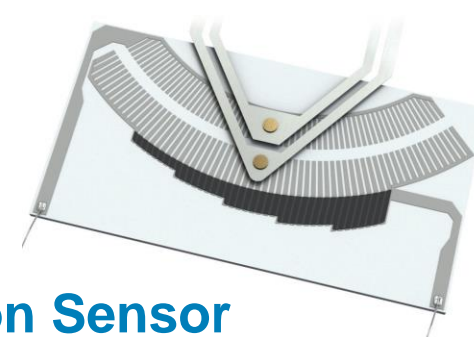


Temperature Sensor

Pt conductor paste

Pacemaker Electrode

Formed out of PtIr



Position Sensor

AuPtPd Thick Film technology



Emission Catalyst

Pt coated

Tools for glass making

Stirrer made of Pt



Precious metals

trading, recycling,
industrial processing



Anti-cancer hAPIs

Cis- /Carbo- / Oxaliplatin



Sensors

for measurements in
molten metal processes:
Pt Thermocouple wire

REQUIREMENTS FROM THE GLASS INDUSTRY

Manufacturing of high quality glasses requires use of equipment with

- › High melting point
- › Good mechanical properties
- › High corrosion resistance
- › Good wetting behavior and no glass coloring effects for optical glasses
- › Complex geometry
- › Long service life

Suitable materials are

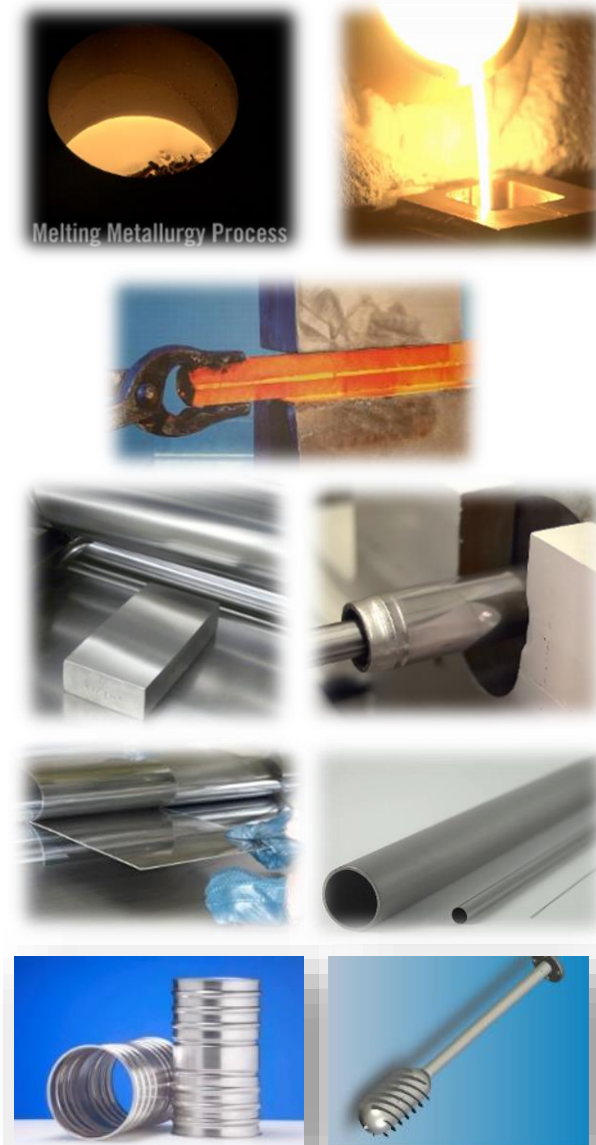
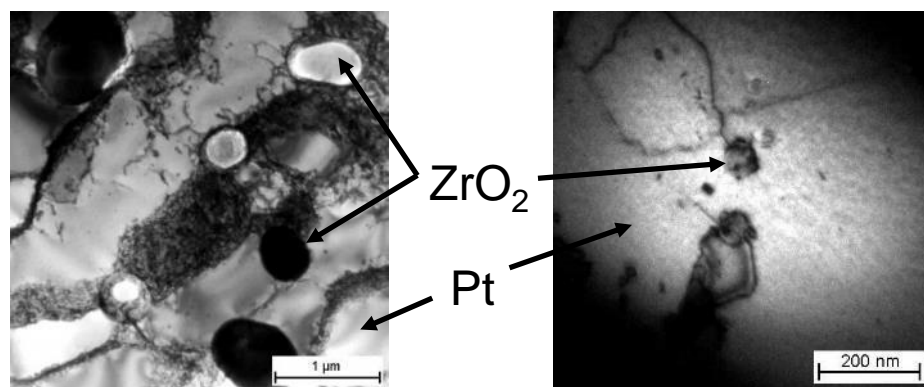
- › Conventional Pt- and Pt-Rh-alloys
- › Oxide dispersion hardened Pt- and Pt-Rh-alloys
 - › DPH: casting metallurgical manufacturing route from Heraeus



DPH AND DPH-A: CASTING METALLURGICAL ROUTE

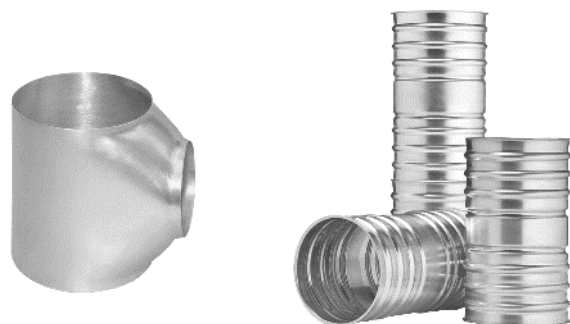
Casting (Pt $T_m=1769^\circ\text{C}$) + Forging + Rolling Oxy-Annealing of sheets / tubes

- › No powder production necessary
 - › No air porosity and no impurities during powder production
- › Internal oxidation of the sheet / tube
 - › formation of ZrO_2 -particles and even distribution inside the grains and at the grain boundaries
- Platinum hardened by ZrO_2 -particles at high temperatures



PROPERTIES OF DPH AND DPH-A MATERIALS

DPH



Materials for tubes and it's components

- › High elasticity in the heating-up phase
- › Robustness to changes in temperature
- › High form stability of the components, even in the weld joints

DPH-A



Materials for active parts like stirrers & plungers

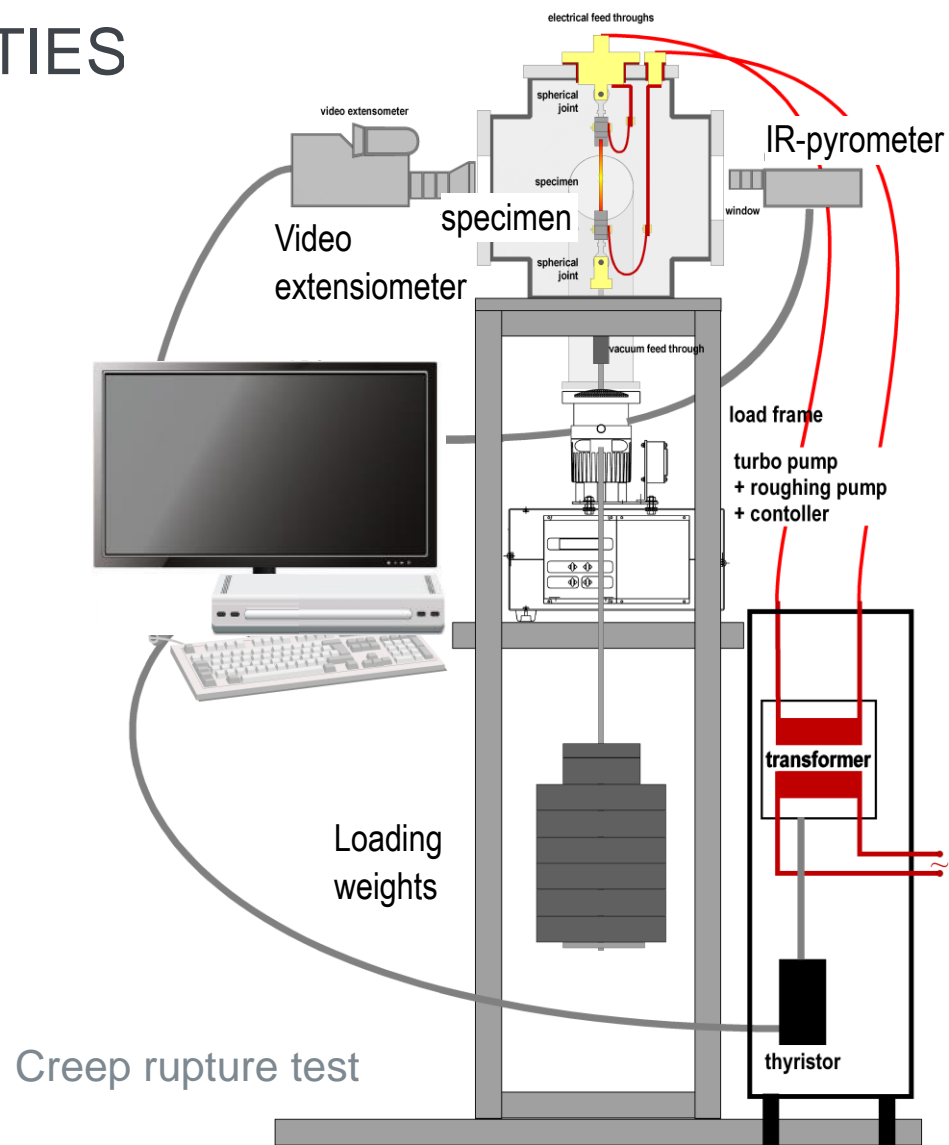
- › Excellent combination of strength and ductility
- › High torsional rigidity for stirrers and plungers

HOW TO MEASURE MECHANICAL PROPERTIES

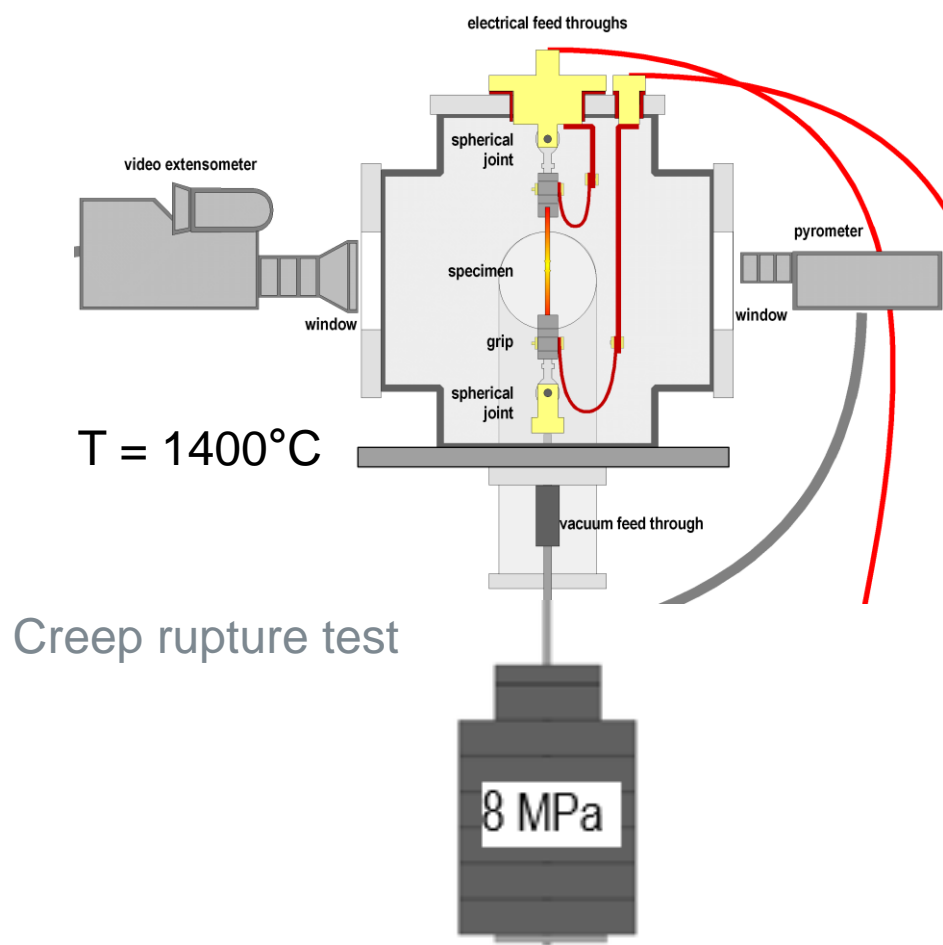
Stress-rupture and creep tests

- › Direct electric current heating
- › IR-pyrometer
- › Temperature controlled by computer Temperature range: 750 - 3000°C
- › Creep curve determination by high resolution camera and the SuperCreep software

Specimen: Strips 120 × 4 × 0.8 mm



MECHANICAL PROPERTIES OF DPH AND DPH-A



Different time to rupture for different materials

- › Pt-10%Rh 10 sec.
- › Pt DPH 1 h
- › Pt DPH-A 30 h
- › Pt-10%Rh DPH 100 h
- › Pt-10%Rh DPH-A 4000 h



Further material improvements in innovation pipeline
Announcement at Glasstec 2020



COMMITTED TO YOUR PRECIOUS NEEDS!