The heat is the heart –
Innovations for thermal process excellence

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Outline

● Introduction
● Kanthal innovations
● Powder metallurgy
● Alumina protection
● Leaner alloys
● Material and components to push the limits
● Success factors forward
Dimensions for innovation

- Conservation of limited resources
- Increased energy efficiency
- Improved productivity
- Technology leadership
Kanthal products for heating and heat resistance

- Kanthal® and Nikrothal® resistance materials
- Special alloys
- Industrial resistance wire and strip
- Seamless extruded radiant tube
- Kanthal® Super, MoSi₂
- Globar®, SiC
- Metallic elements
- Porcupine industrial air heating
- Semiconductor/Solar process heating
- Fibrothal™ heating modules
- Metal process heating
- Services
- Kanthal APMT™ High temperature construction materials and components
- Kanthal APMT™ furnace rollers

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Kanthal APMT high temperature construction products

A wide range of products for specific applications

- Retorts
- Tubes
- Muffles
- Furnace rollers
- Nozzles
- Flanges
- Baskets and trays
- Wire mesh
- Thermocouple protection
Alumina, $\alpha$-Al$_2$O$_3$

- Corundum, $\alpha$-Al$_2$O$_3$, is the stable crystal structure at high temperature
- Hardness 9 in the Mohs scale
- Alumina, Ruby, Sapphire, Sapphire glass – synthetic single crystal
- Melting point 2030 – 2050 °C
- Thermodynamically very stable
- Unaffected by most chemicals except very hot caustics

Alumina protective scale (Kanthal APMT, 1300°C (2372°F), 1100 hours)
Alumina protection

- High temperature oxidation performance
- Max. operating temperature
- Chromia formation upper limit
- Alumina forming alloys
- Chromia forming alloys

Strength at high temperature

- 1300°C
- 1200°C
- 1100°C
- 1000°C
- 900°C
Alloy evolution

Strength at high temperature

High temperature oxidation performance

Max. operating temperature

Conv. Kanthal → Kanthal APM → Kanthal APM HP → Kanthal APMT

Chromia formation upper limit

Ni-base HT alloys

Ni-base superalloys

900°C → 1000°C → 1100°C → 1200°C → 1300°C
Lean Alloys

Performance Function

Nickel
Kanthal APMT applications

Retorts for PM, MIM sintering, AM and CVD

- Higher temperature possible 1250°C (2282°F)
- Longer service life
- Small spallation of oxide scale
- No Cr-containing volatiles
- Facilitator
- Problem solver
- Productivity and energy saving

CVD coatings

SmCo magnets

CoCr implants

Sandvik
Furnace Rollers

- High temperature oxidation properties and mechanical strength
- Process temperature up to > 1200°C (2192°F) is possible in oxidizing atmosphere
- Longer service life and reduced maintenance cost
- Better surfaces on the heat treated product
- Reduced or eliminated need for cooling
- Large energy savings and higher productivity

Kanthal APMT applications

Roller hearth

Walking beam
High temperature air heating

Customer driven product development: Air and gas heating up to 1200°C (2192°F)

- Catalyst production
- SOEC systems (Solid Oxide Cell technology for Electrolysis, SOEC technology)
- Shrink plastics
- Etc.

Versatile design
Patent pending

Air heater
40kW, 100m³/h, 1200°C (bench test)
Kanthal Services

Customer needs - Our solutions

- **Electrical Heating Systems**
  - Analysis, design, production, commissioning

- **Engineering Service**
  - re-engineering, refurbishment, conversions

- **Technical Service**
  - energy audits, financial services, contracts

- **Custom made solutions**
R&D resources

Vacuum hot wall retort - test facility

Retort tested at 1200°C
Our obligation

- Minimize waste
- Minimize consumption of resources
- Minimize pollution
Looking ahead..

- Embrace innovations
- Combined efforts over the supply chain are necessary and pay off
  - so let us work together for sustainable thermal processing!
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