



Development and Performance Evaluation of Zirconia Crucibles for Superalloy Processing

Ronny Simon, Product Manager Crucibles
Zircoa Inc.

34th EICF Conference & Exhibition
SICC Seville, Spain
May 10 – 13, 2026

Who we are



- Zircoa Inc., USA
 - Headquarters
 - Founded 1952
 - ISO 9001:2015 with Design
- Zircoa GmbH, Germany
 - Sales office EMEA & India
 - Founded 2012
 - 100% Subsidiary of Zircoa Inc.



Outline



- Introduction and motivation
- Zirconia material background
- Market dynamics and challenges
- Development approach
- Results from raw material evaluation
- Field-trials and postmortem analysis
- Conclusions and outlook

Introduction and Motivation (1)



Crucibles serve as primary containment for melting alloys prior to casting

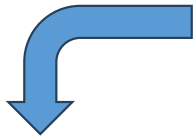
- Provide clean melts
- Withstand high temperatures
- Repeated heating cycles
- No interactions with reactive alloys

Often crucibles operate near thermal and mechanical limits

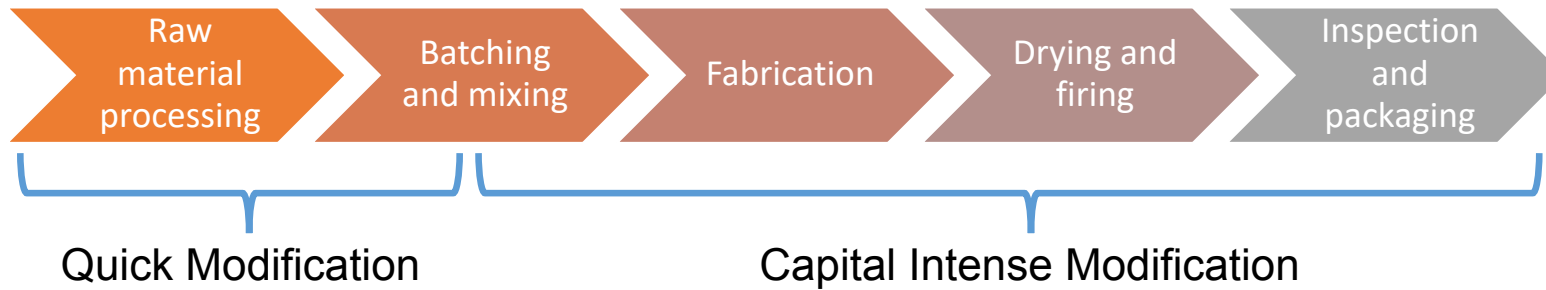
Property	Zirconia
Max temperature	Very high (1800-2200 °C)
Thermal shock resistance	Medium
Chemical inertness	Very good – Excellent
Sustainability	Multi-use option



- Raw material availability
- Cost of material and shipping
- Geopolitical impacts



Process Flow Chart for Zirconia Crucibles

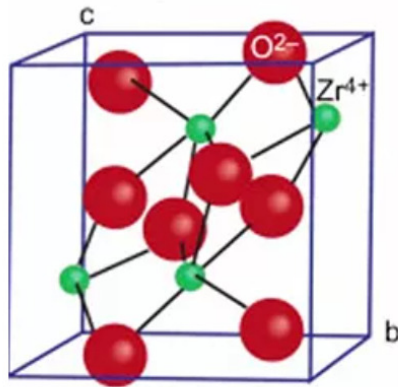


- New raw material suppliers
- Warehousing
- Need for additional processing (crushing, sieving, screening)

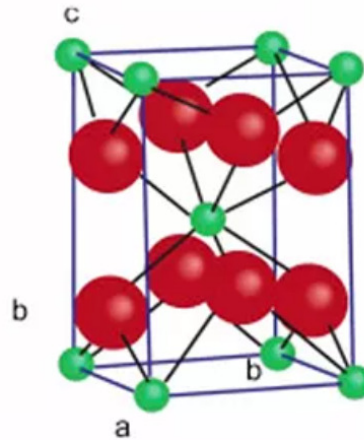


Typical Crystall Structures of Zirconium Oxide - Zirconia

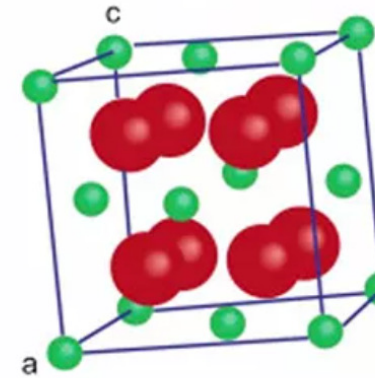
Monoclinic



Tetragonal

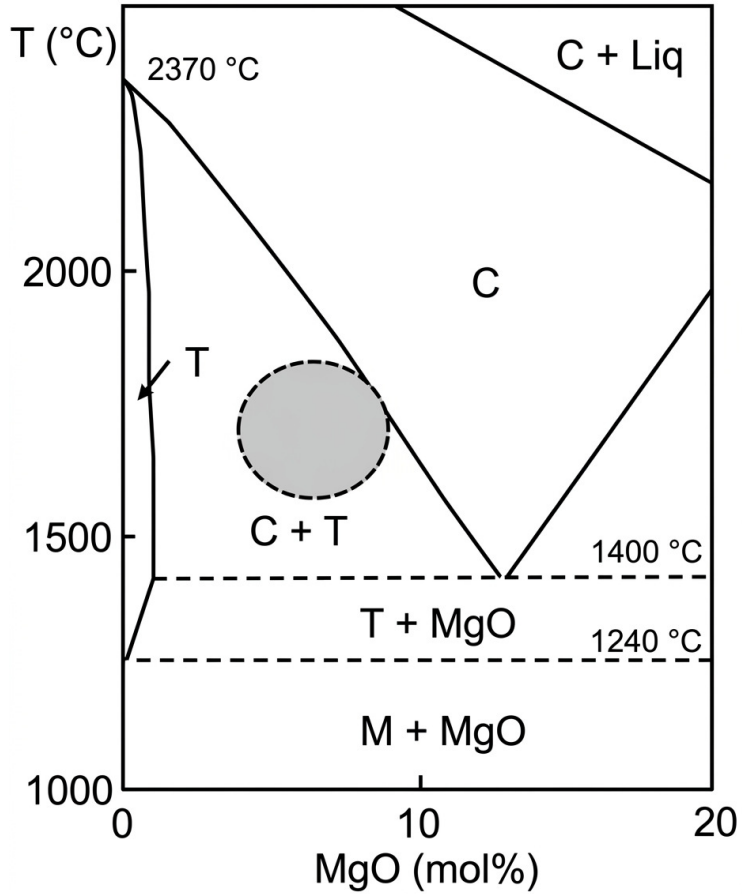


Cubic

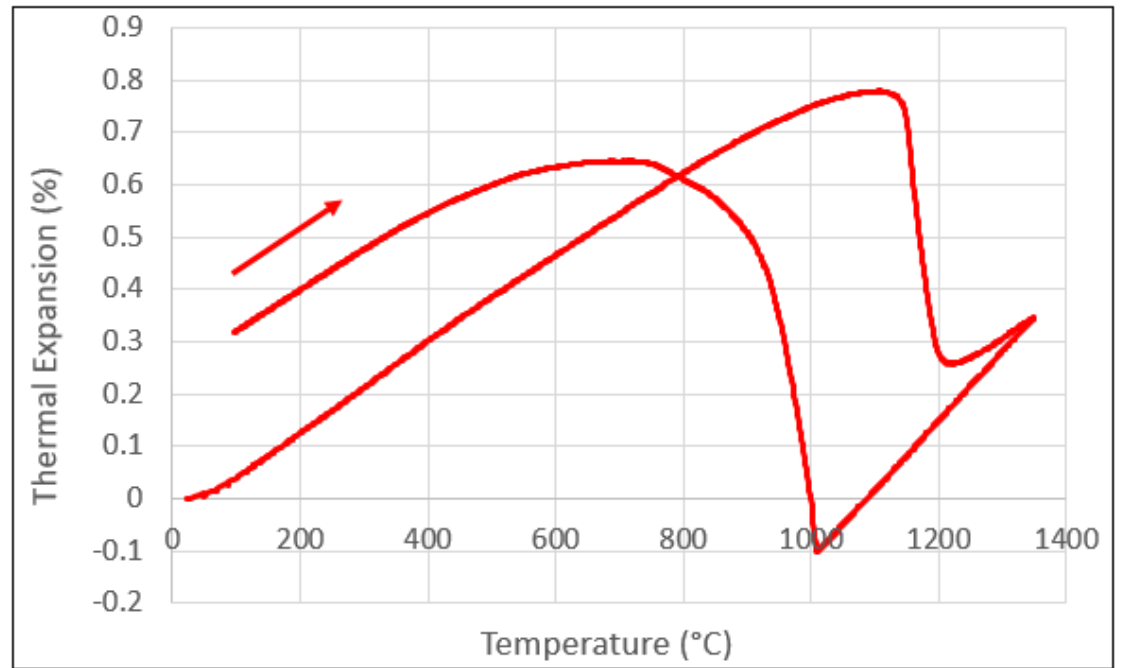


~1,170 °C

~2,370 °C



Magnesia – MgO Partially Stabilized Zirconia (PSZ)



Evolving Industry Demands

Higher operating temperatures for novel alloy compositions

Greater purity requirements to reduce contamination

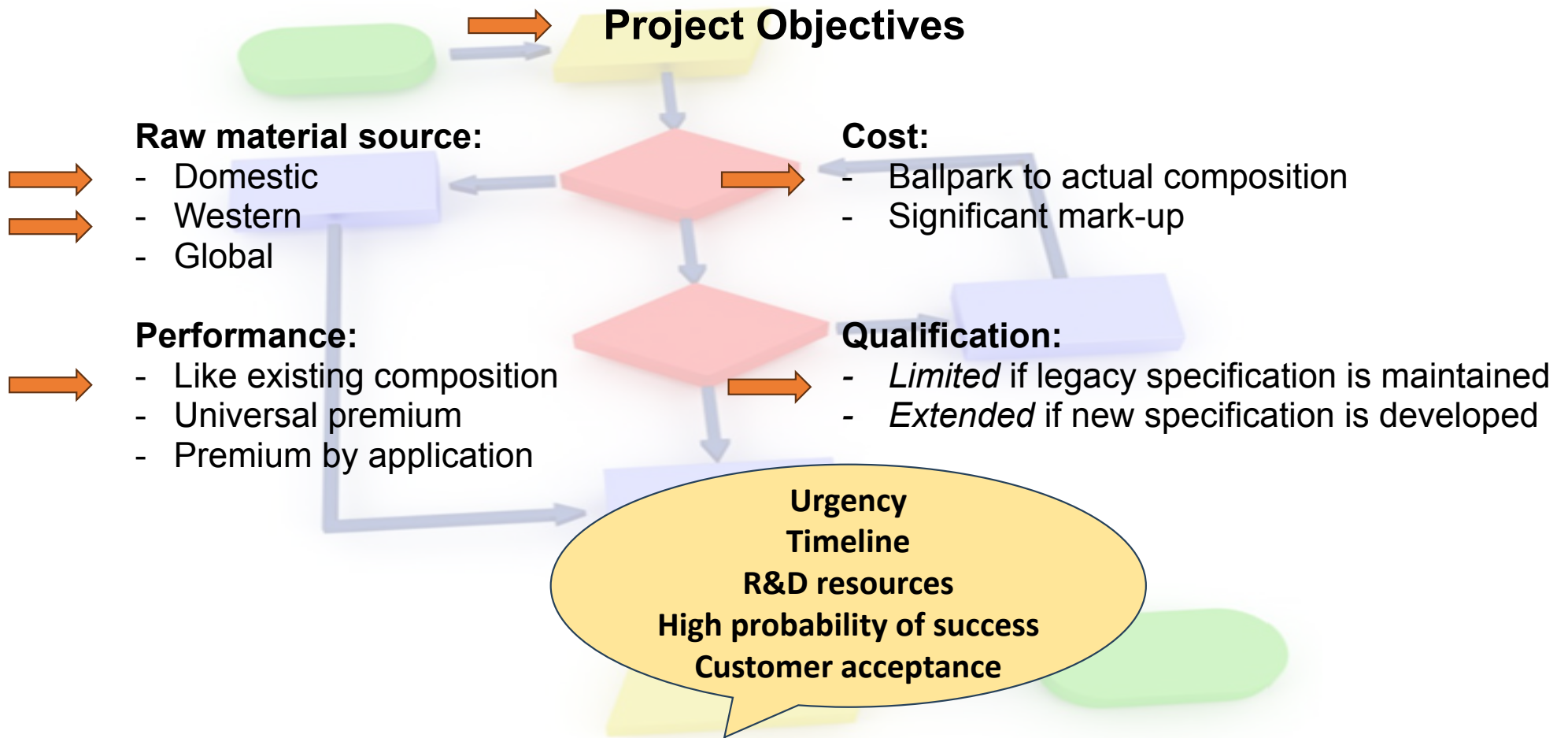
Equiaxed vs. Directional vs. Single Crystal

Supply Chain Drivers

Geopolitical risks affecting raw materials

Availability and stability of refractory oxides

Cost sensitivity in a competitive environment



Full Analysis of Crucible Applications

Furnaces:

- Vacuum induction melting
- Open air melting (roll-overs)

Alloys:

- Nickel based superalloys melting
- Cobalt based superalloys melting

Melting Process:

- Continuous melting in a high-volume casting process
- Discontinuous or low-volume casting process

Casting Process:

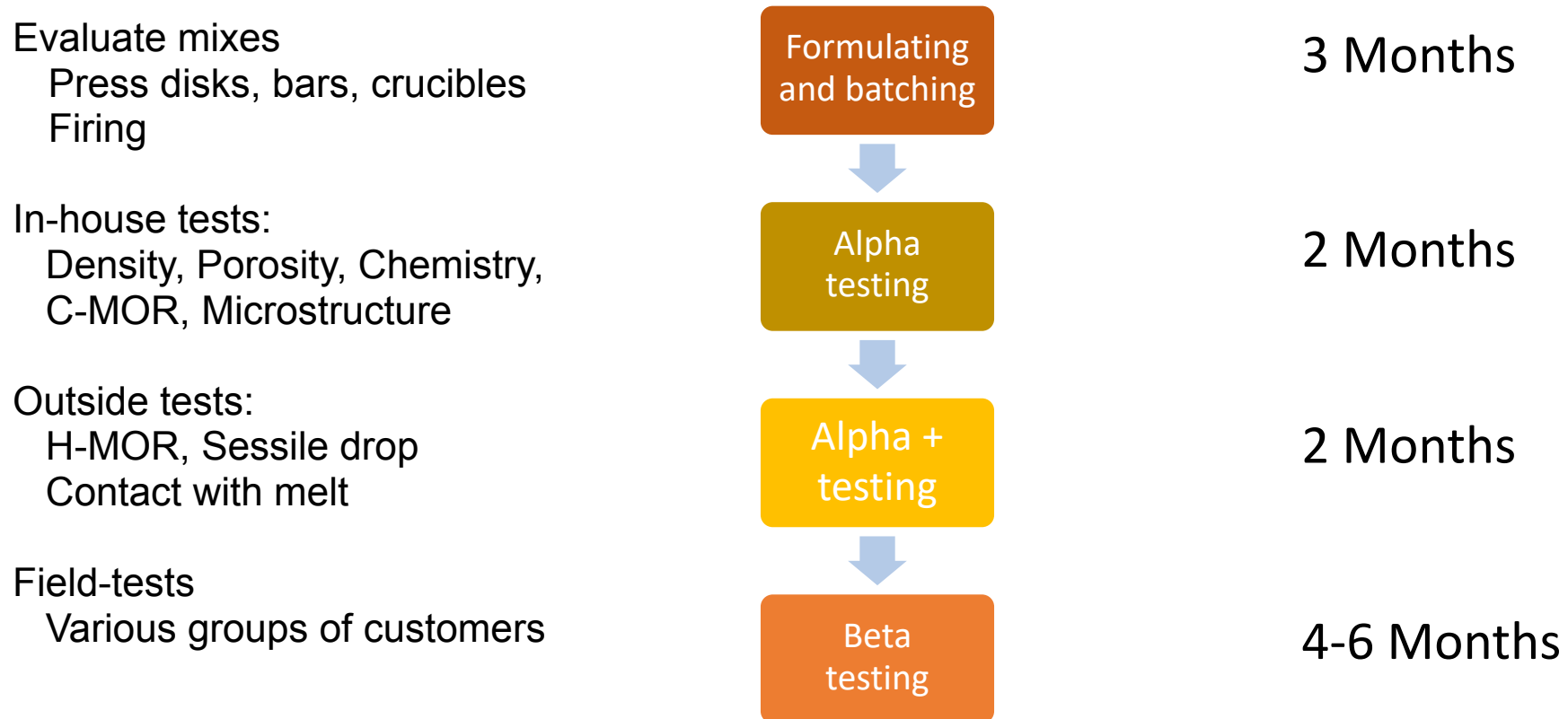
- Equiaxed Solidification
- Directional Solidification
- Single Crystal Solidification

Properties that matter:

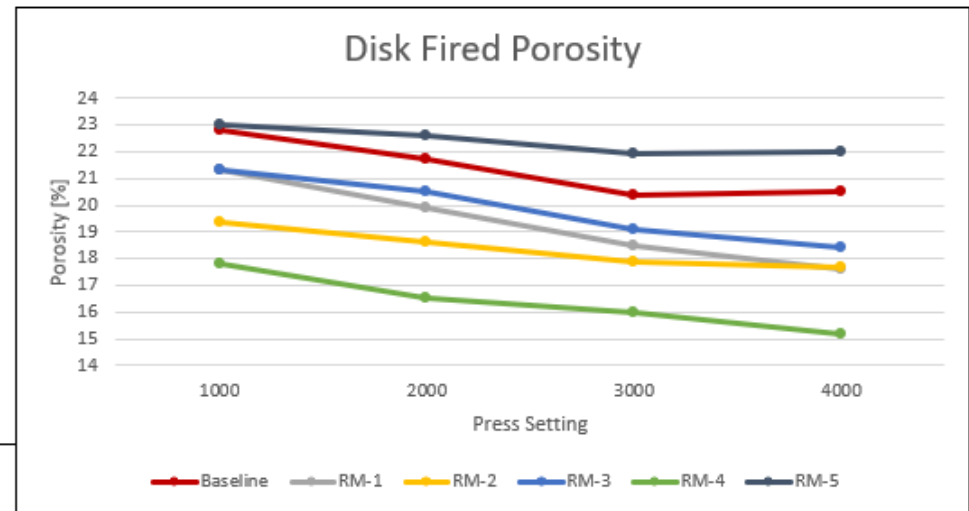
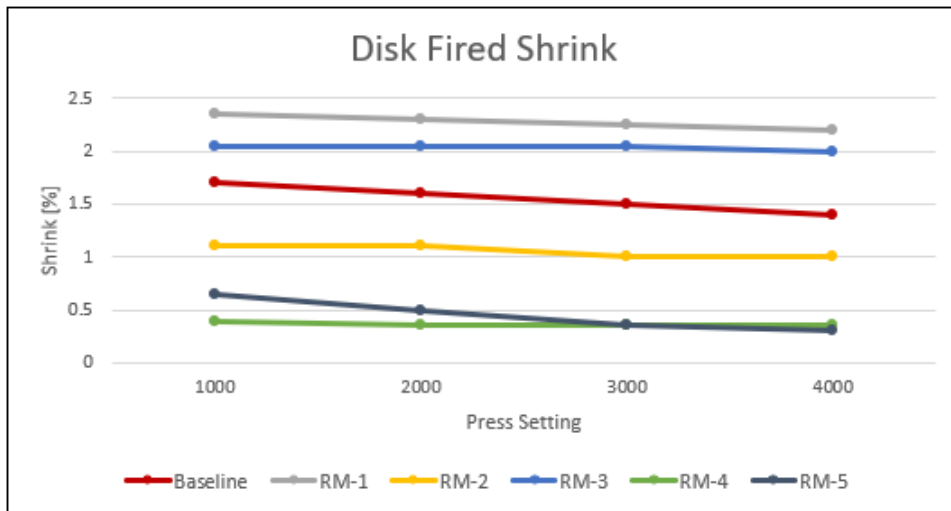
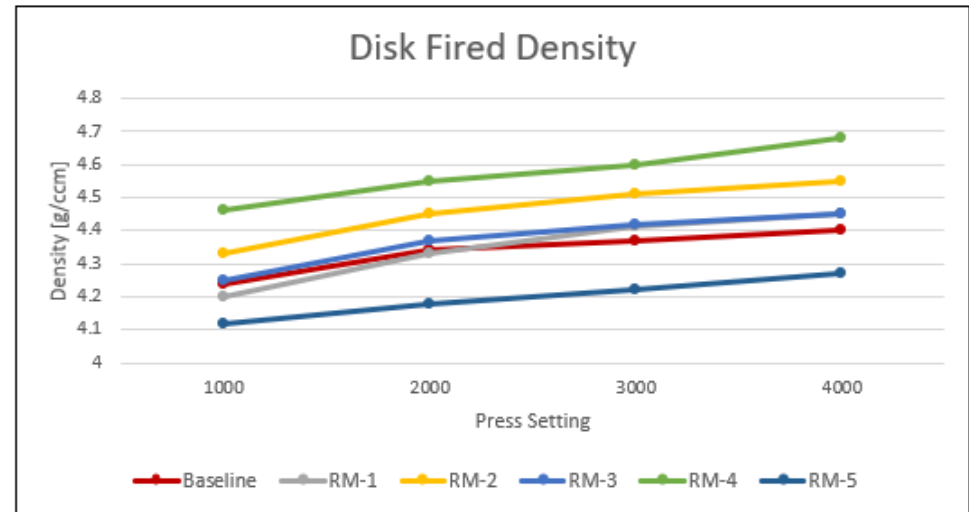
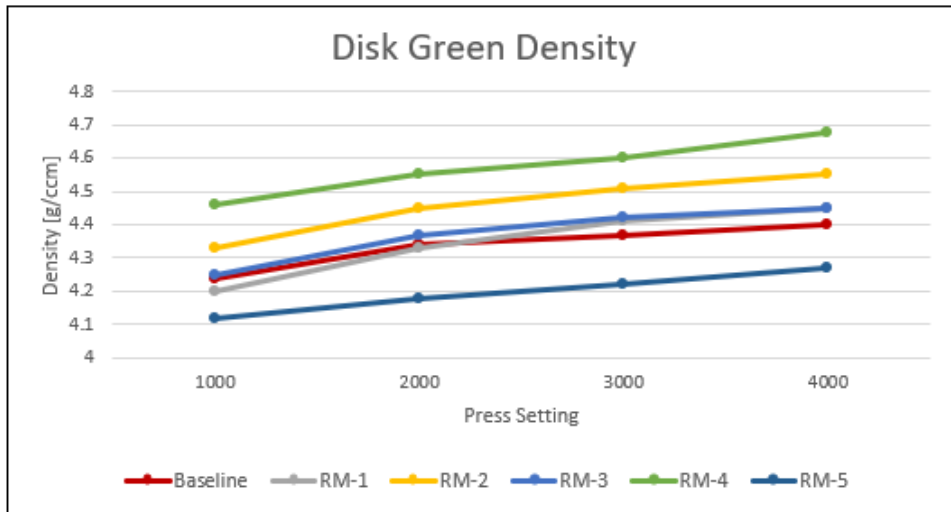
- Chemistry
- Density
- Porosity
- Monoclinic content
- C- and H-MOR
- Hardness
- Thermal expansion
- Erosion resistance
- Inertness

*Focus on properties
to predict
performance*

Shaping the workflow for trials



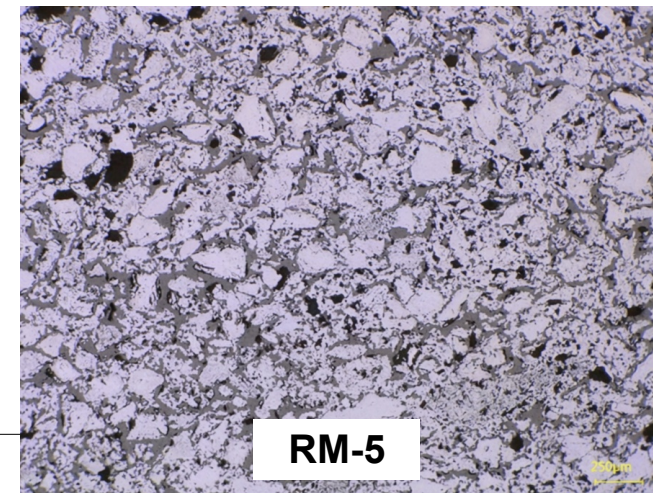
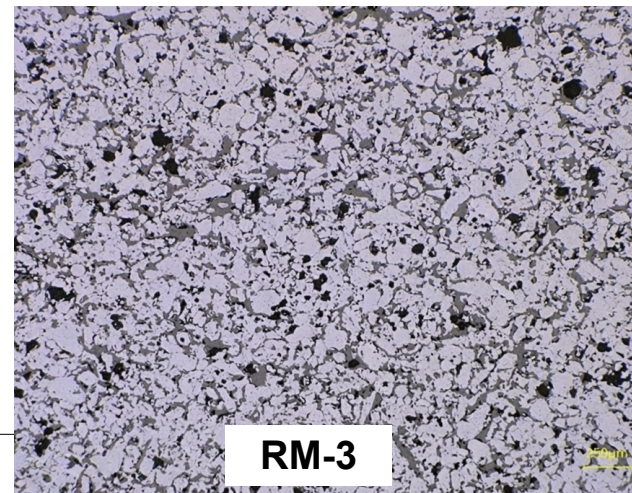
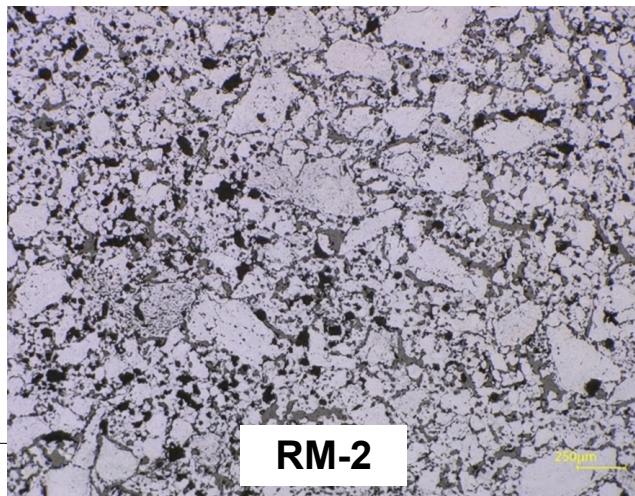
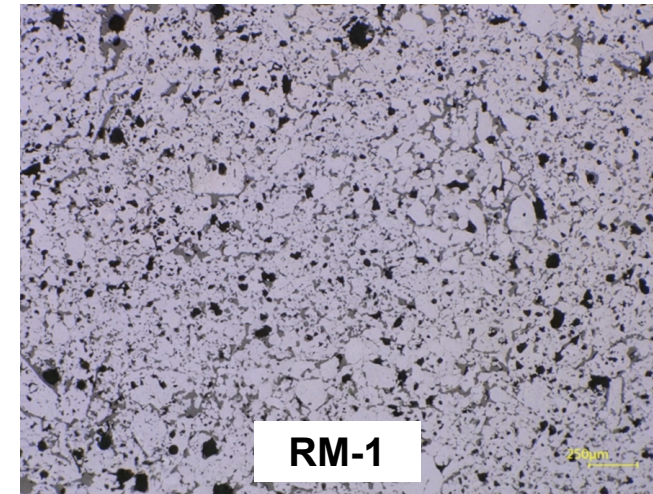
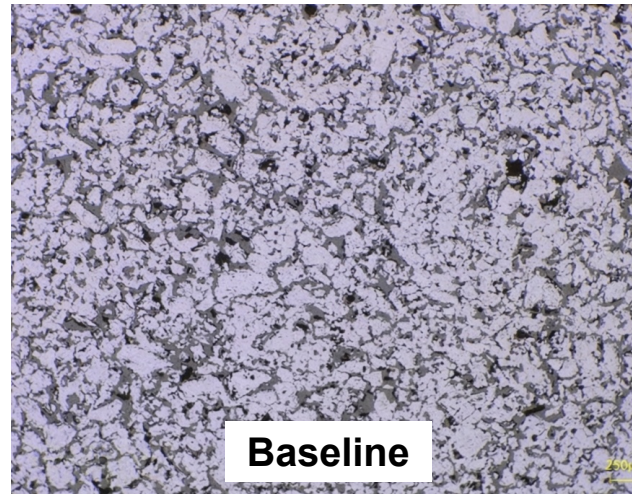
RM Evaluation - Baseline vs. Various Raw Material Suppliers (1)



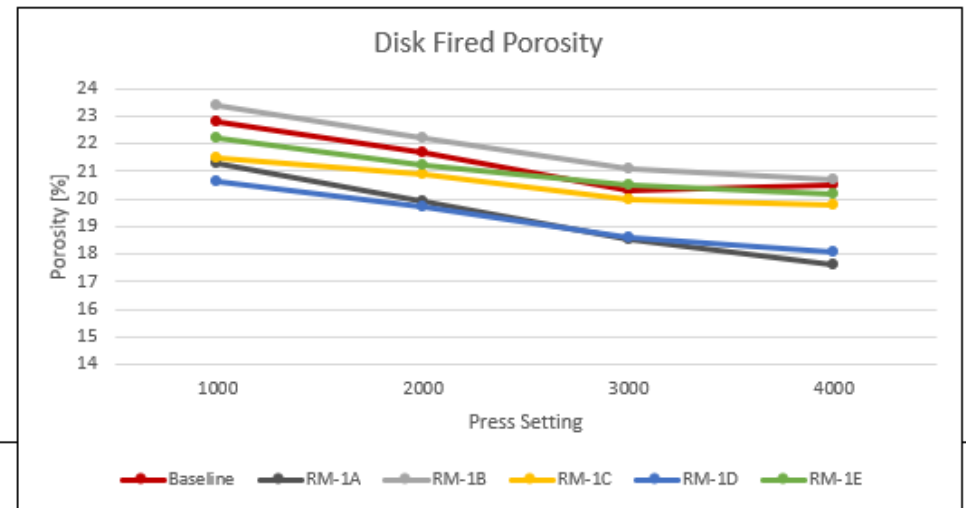
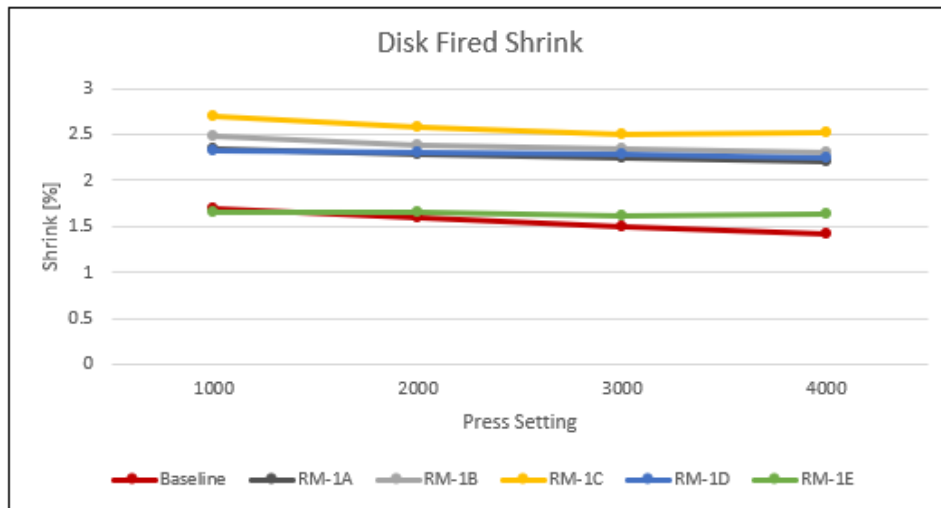
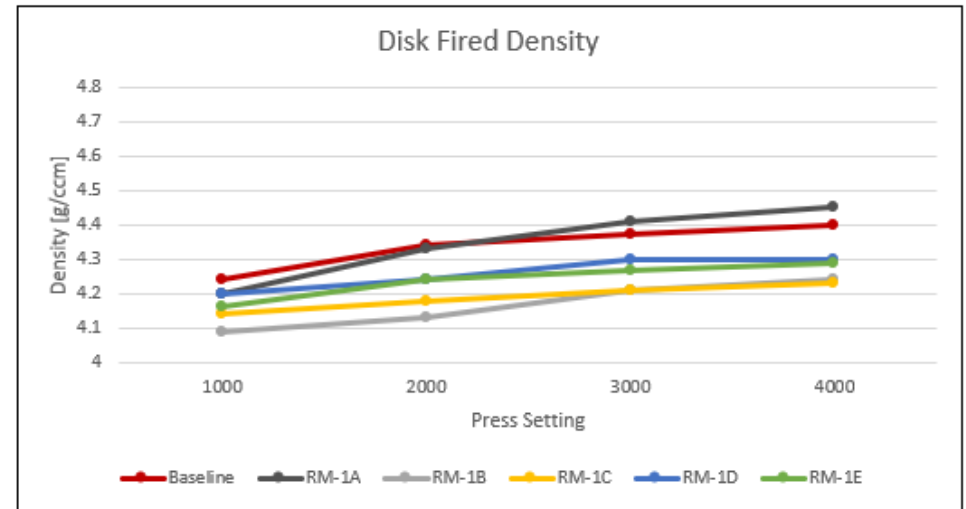
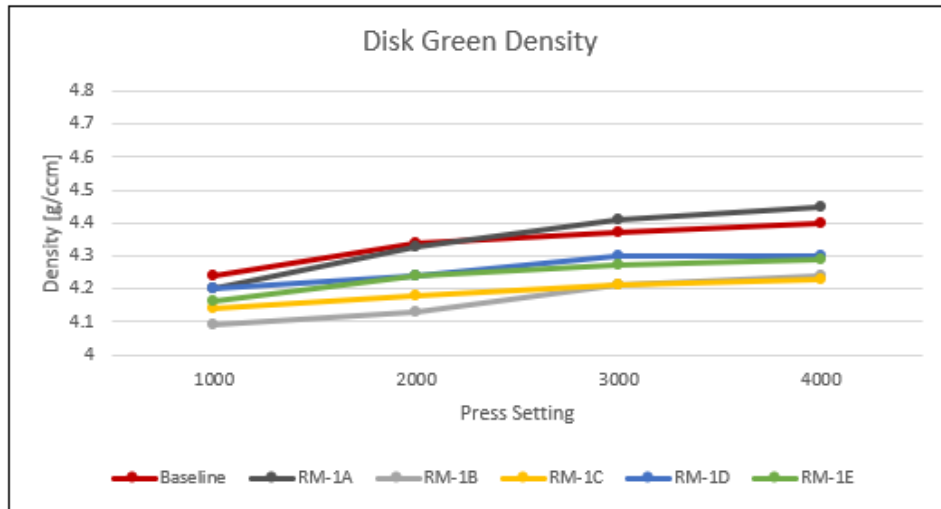
RM Evaluation - Baseline vs. Various Raw Material Suppliers (2)



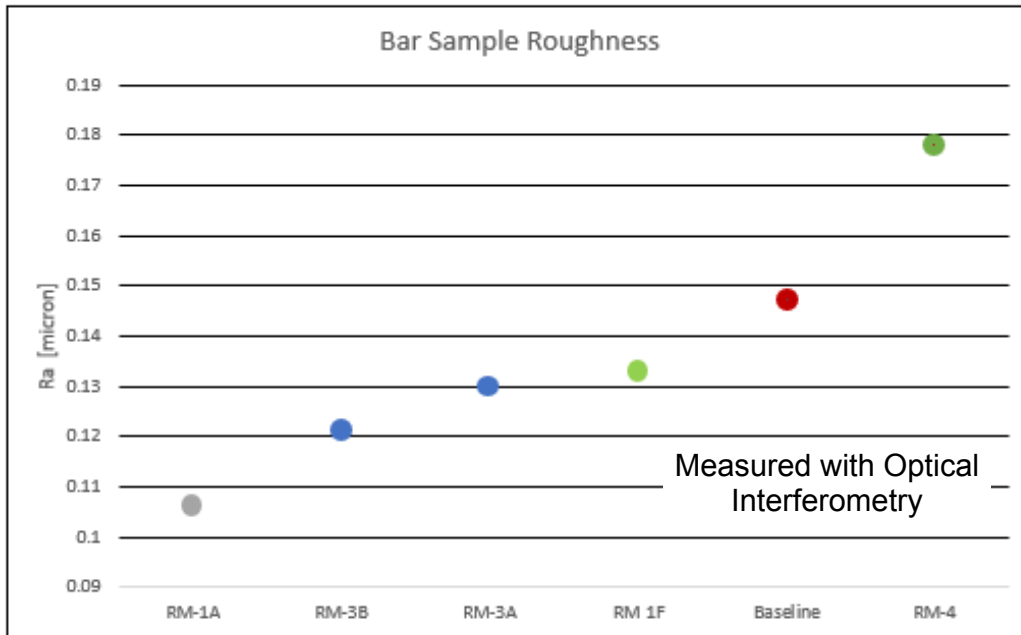
Microstructure
Disk, fired
100x mag.



RM Evaluation - Baseline vs. RM-1 Variants



RM Evaluation – Roughness Data



Smoother surface

- + Less slag and melt stick to the surface
- Closer contact to melt and more interaction

Coarser surface

- + Less interactions with melt
- Particles break off and contaminate the melt



S-2686-8.0 equivalent

- OD 100 mm
- ID 85 mm
- H 200 mm
- Round bottom
- MgO PSZ development composition

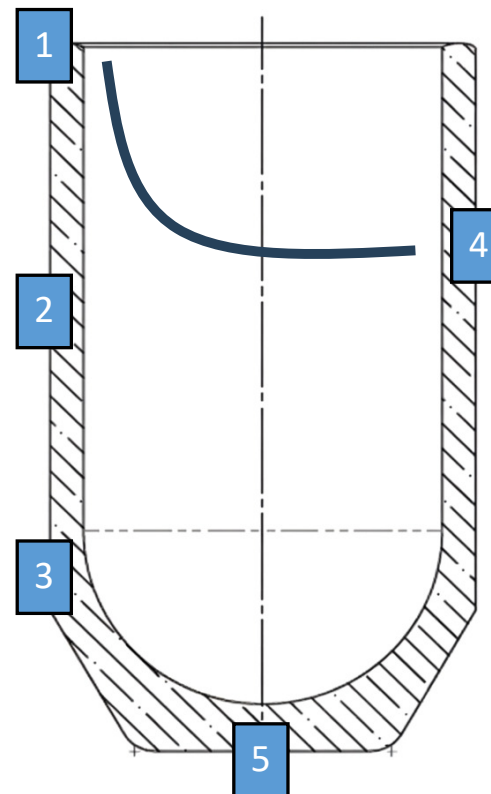
22 lbs / 10 kg of Ni based superalloy

1860 °C peak temperature

Vacuum induction melting

Analysis after 40 melts

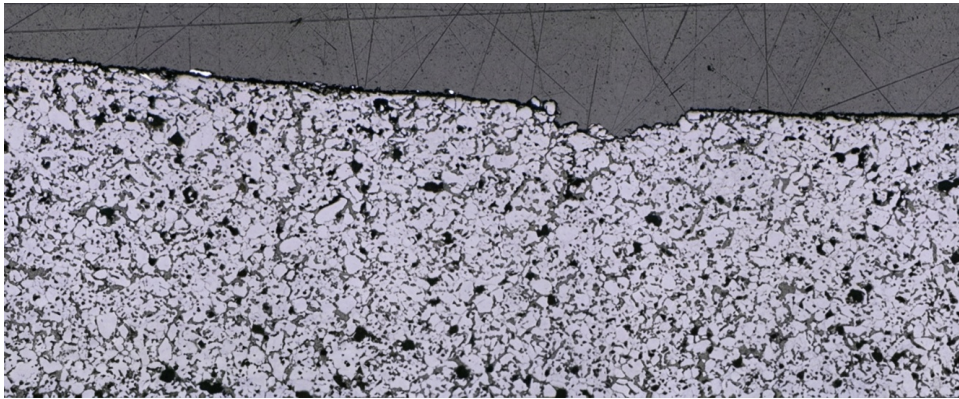
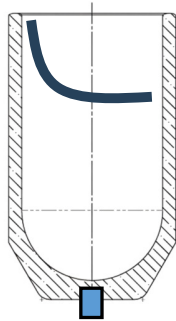
Postmortem Analysis from Field-Trials (2)



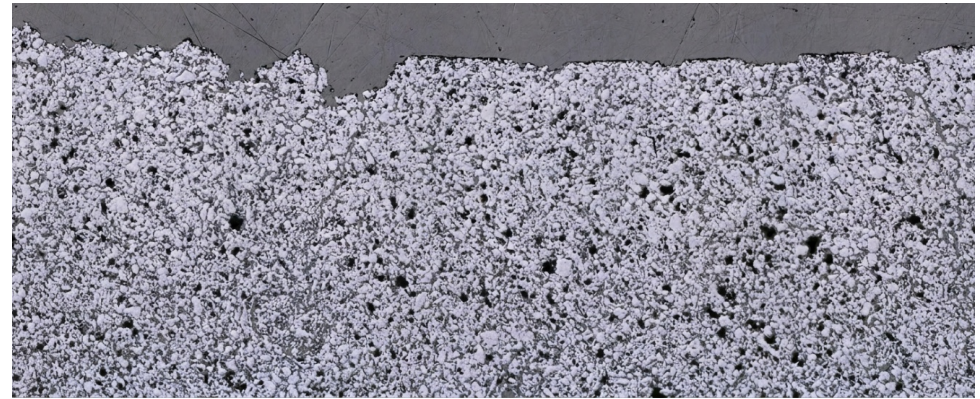
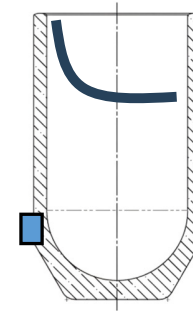
- 1 – Lip area (pour path)
- 2 – Side wall
- 3 – Knuckle
- 4 – Melt line
- 5 – Bottom

Postmortem analysis is used in development work, but it is also a widely used service tool for qualifying failure modes in daily operations

Postmortem Analysis from Field-Trials (3)



Surface integrity maintained
Microstructure tightly bonded
No alloy infiltration



Slightly higher porosity
No crack formation
No alloy infiltration

- **Material Integrity:** New raw material sources met or exceeded baseline properties
- **Process Stability:** New compositions are compatible with existing manufacturing route
- **Field Prove:** Postmortem analysis confirms microstructural stability
- **Supply Resilience:** Validated sources reduce geopolitical risk

- **Expansion of Field-Trials:** Moving from “Alpha” testing to “Beta” tests in Q3/Q4 2026
- **Zircoa’s Commitment:** Continuing to decouple high-performance ceramics from single-source raw material dependencies

Develop premium compositions for high-demanding applications with high-quality requirements



Ronny Simon

rsimon@zircoa.com

+1 216-440-2283

Tobias Schmidt

tschmidt@zircoa.com

+49 611-335497-21

