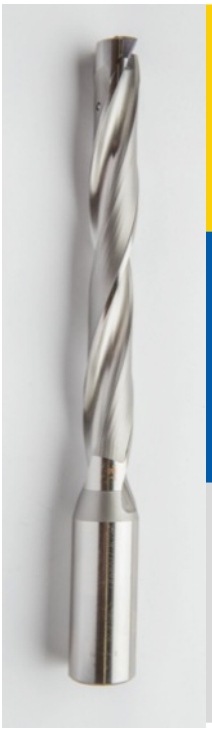
Kennametal – Additive Manufacturing

High-Performance Material & Component Solutions

Drake Cargnino - Business Development Engineer
Kennametal Stellite
Tuesday, July 23rd 2019

KENNAMETAL®

One of the world's leaders in tooling & wear resistant solutions



Founded in 1938
in Latrobe, Pennsylvania by Philip McKenna

Revenue $2.4B+
in Fiscal Year 2018

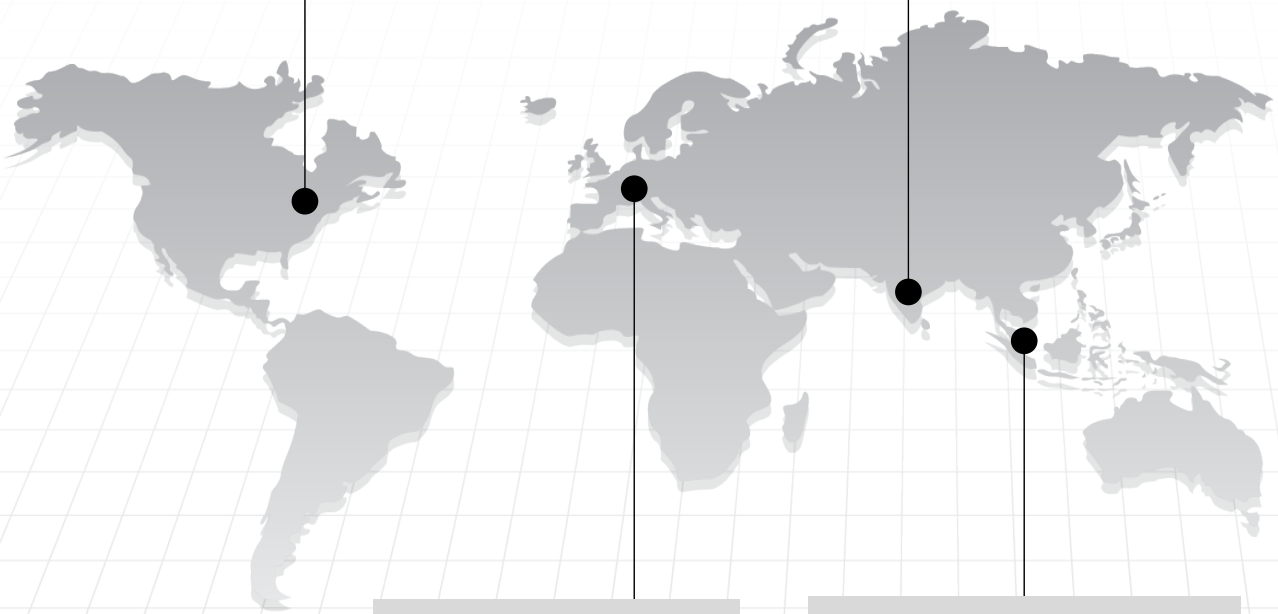
Employs 10,000+
team members throughout the world.

Kennametal delivers productivity to customers seeking peak performance, by providing innovative wear-resistant solutions, enabled through our advanced materials science, application knowledge, and commitment to a sustainable environment.

Organizational Snapshot

World Headquarters:
Pittsburgh, PA, USA

India Headquarters:
Bangalore, India



EMEA Headquarters:
Neuhausen, Switzerland

Asia-Pacific Headquarters:
Singapore, Singapore

AT A GLANCE

Serving
80,000+ Customers

In more than
60 Countries

Holding
1,700 Active Patents

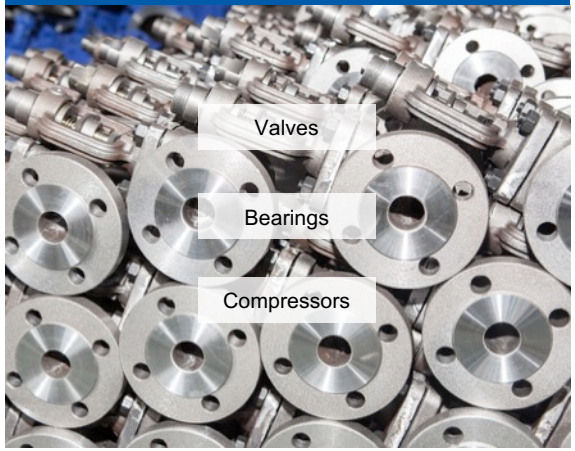
Headquarters in
Pittsburgh, Pennsylvania, USA

KENNAMETAL

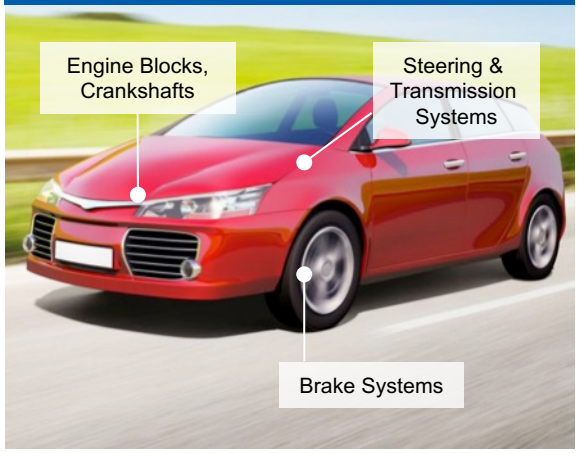
Making the Everyday Possible

AEROSPACE

GENERAL ENGINEERING

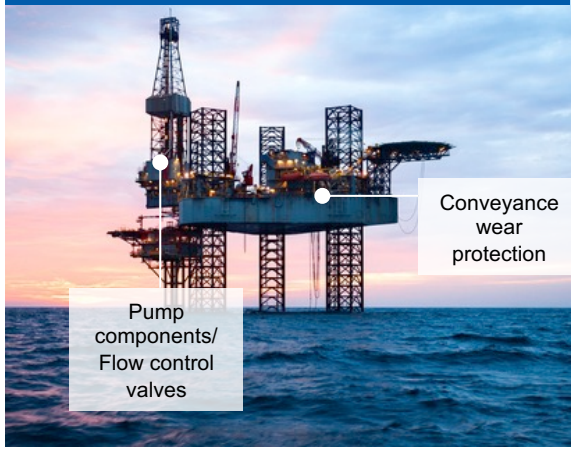


TRANSPORTATION



EARTHWORKS

ENERGY



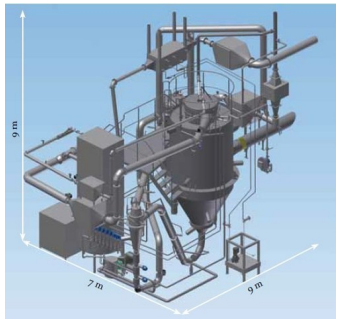
…AND MORE

Why Additive Manufacturing?

Materials & Powders Built on Legacy Know-How

Material Grades & Alloys

- Industry leader in WC & Stellite®
- AM-specific options based on strong materials competency



Powder Production

- Powder producer w/ decades of experience
- Optimizing compositions & forms for AM

Expertise in Post-Print Processing & Qualification

Post-Print Processes

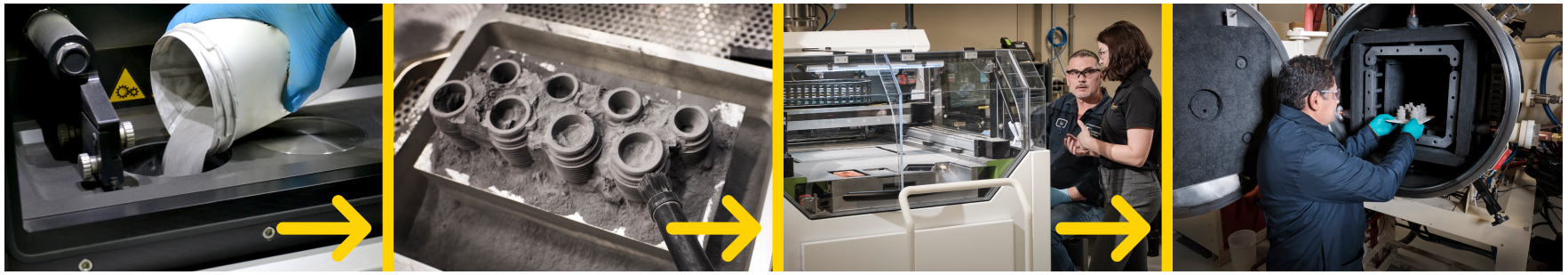
- Expertise in sintering, green processing & machining
- Sintering competency & capabilities

Trusted Supplier

- Decades of reliable components in high-demand environments
- Existing qualification and inspection capabilities

KENNAMETAL

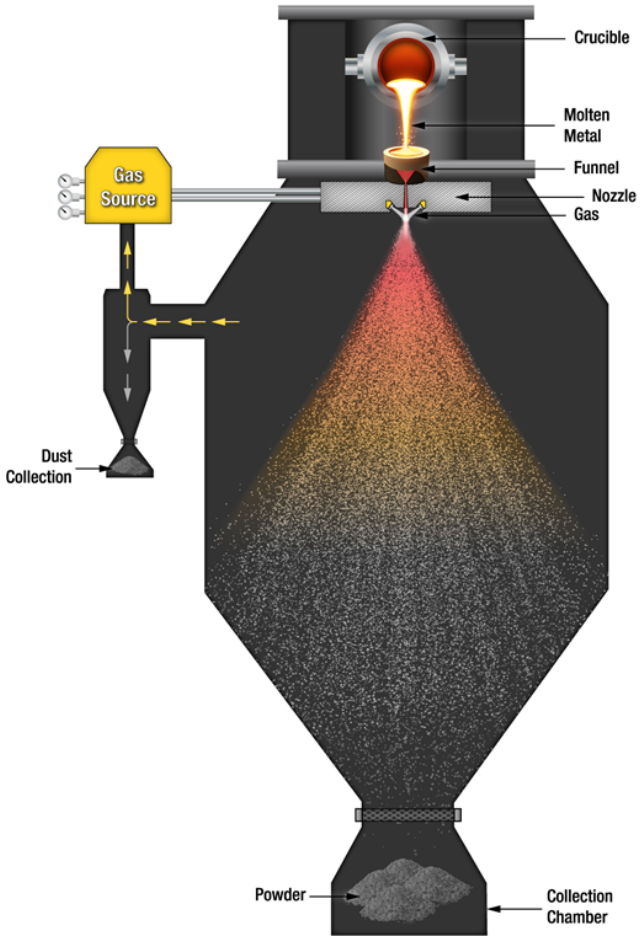
Investing in the Entire AM Flow-Path for Success

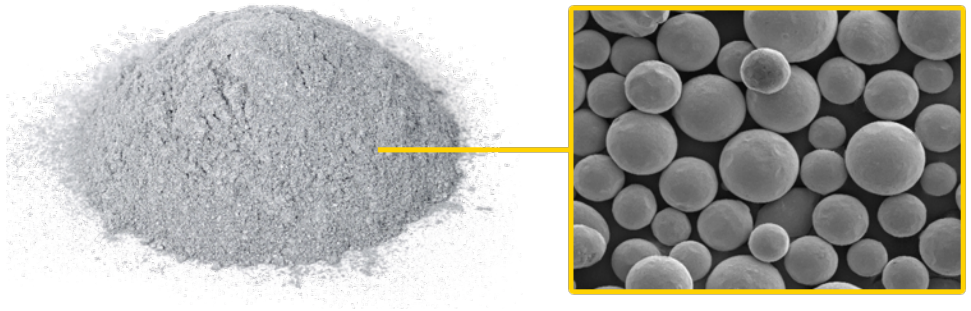


Powder Production

Component Generation

Production of Additive Manufacturing Powders



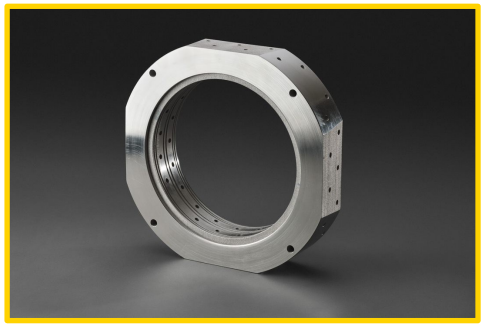


	ALLOY	BASE METAL	MECHANICAL WEAR	CORROSION	HIGH OPERATING TEMPERATURE
Resistance Low Satisfactory Very Good Excellent	Stellite™	Cobalt	■■■	■■■	■■■■
	Nistelle™	Nickel	■	■■■■	■■■
	Delcrome™	Iron	■■■	■■	■■

Powder Competencies

- Inert Gas Atomization
- Co-, Fe-, and Ni-based Alloys
- Powder Bed Fusion, Direct Energy Deposition, and Binder Jetting
- Aerospace, Automotive, Medical, Oil & Gas, and more
- Direct to customer metal additive powders

Component Generation



1. Additive Manufacturing Powder

Portfolio of internally manufactured Cobalt, Nickel, Steel, Tungsten, and Tungsten Carbide Powders optimized for different additive manufacturing platforms.

2. Design Optimization & Prototyping

In-house design engineers and design optimization technologies with prototyping capacity for shorter development cycles and design iterations.

3. Printing Technologies for Additive Manufacturing

Binder jet and laser powder bed fusion printing of components using Kennametal Stellite™ powders and Tungsten Carbide.

4. Post-Print Processing & Qualification

Sintering, green processing, heat treating, hot isostatic pressing, machining, material and component performance testing.

Customer Case Study: IMI Critical Engineering

Stellite™ Valve Cage

Kennametal AM materials and components, such as this Stellite™ valve cage, go the distance for IMI Critical Engineering

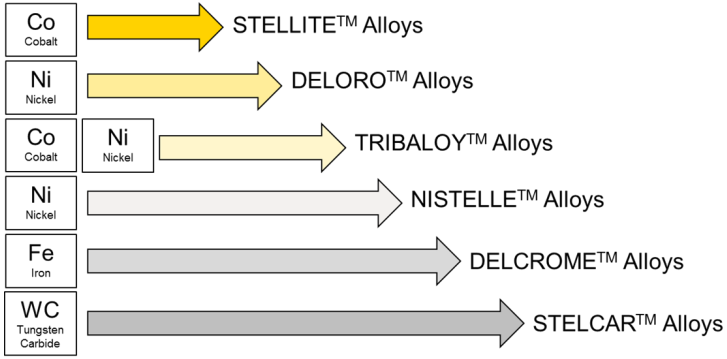
IMI Critical Engineering is a leading supplier of highly engineered flow control systems to major energy and industrial process companies.

Kennametal is partnering with IMI to supply high-performance AM components and materials, such as this complex **valve cage** for a **special application in a combined cycle power plant**.

Printed using our proprietary **Stellite™ 6-AM-K powder**, the component demonstrated excellent wear performance in rigorous field trials where it was exposed to highly erosive environment.

KENNAMETAL STELLITE: Goshen Operations

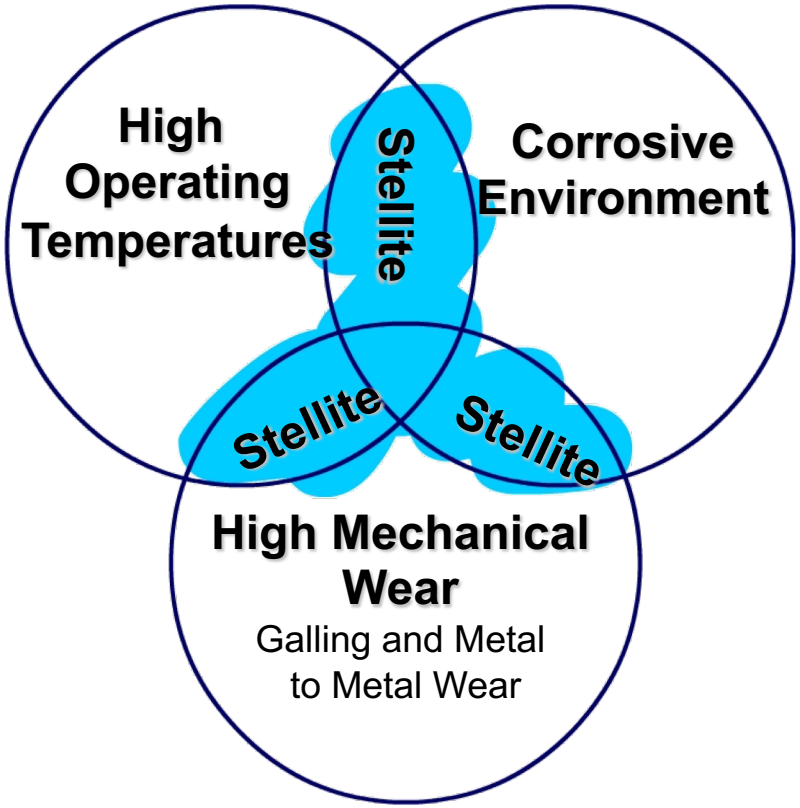
- **Goshen Plant - Materials**
  - 56,000 SQ-FT of manufacturing floor space
  - Focus on the production of base materials
  - 300 Unique Co-, Fe-, and Ni-Based Alloys and WC
  - Continuous Casting, Wire Drawing, & Gas Atomization



	ALLOY	MECHANICAL WEAR	CORROSION	HIGH OPERATING TEMPERATURE
Resistance Low Satisfactory Very Good Excellent	Stellite™	■ ■ ■	■ ■ ■	■ ■ ■ ■
	Deloro™	■ ■ ■	■ ■	■ ■
	Tribaloy™	■ ■ ■	■ ■ ■	■ ■ ■ ■
	Nistelle™	■	■ ■ ■ ■	■ ■ ■
	Delcrome™	■ ■ ■	■	■ ■
	Stelcar™	■ ■ ■ ■	■ ■	■ ■

Why Stellite?

With over 100 years of proven performance, Kennametal's Stellite™ alloys have become known as the worldwide material solution in wear, heat and corrosion applications.



KENNAMETAL™
STELLITE

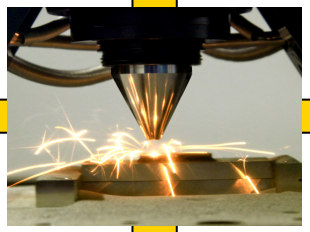
KENNAMETAL

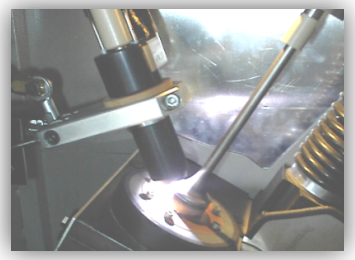
Industries Served

- Aerospace
- Oil & Gas
- Automotive
- Power Gen
- Steel
- Dental
- Timber



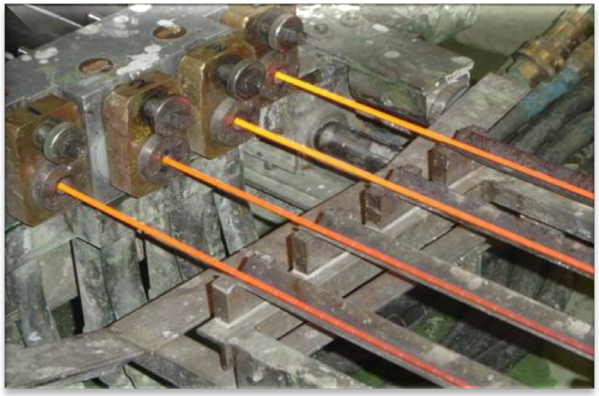


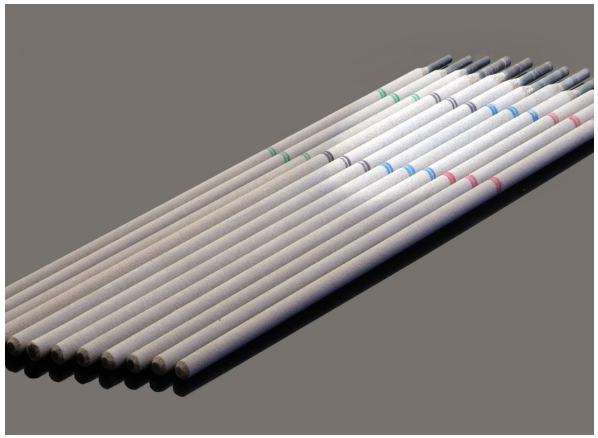
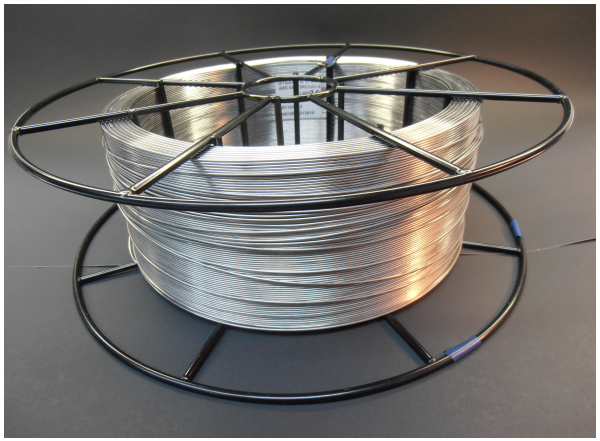


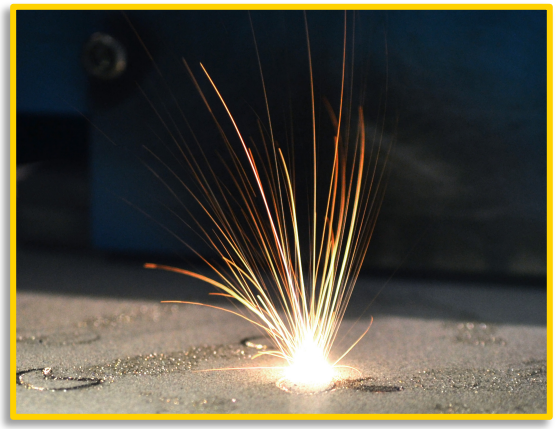

Traditional Business

Rod	Cored Wire	Powder
TIG, GTAW, MMA	MIG (GMAW), SAW	PTA, Laser, HVOF, Powder Welding, **Additive Manufacturing**



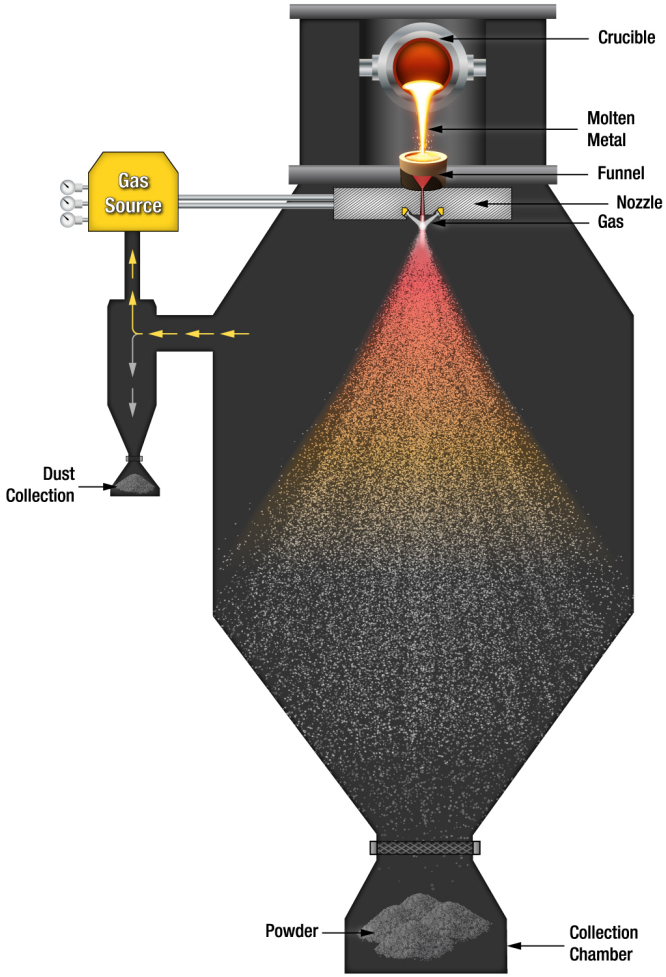





Looking to the Future



Powder Manufacturing

Inert Gas Atomization

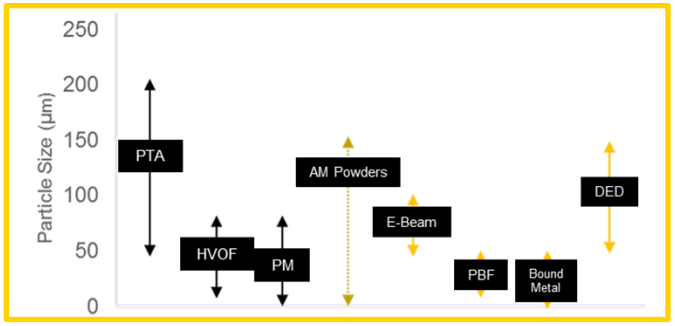


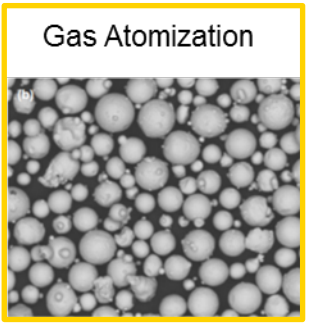
Process Characteristics

- Most common process for generation of AM Material
- Generates **spherical particles** with good flowability
- Produces powders with **high particle density**
- Allows for production of **wide range of alloys**

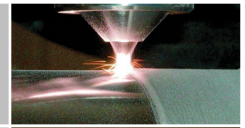
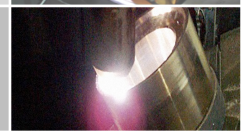
Post-Atomization Processing

- Atomized particles are sifted for correct particle sizing
- Powder undergoes quality testing for optimal:
  - **Powder Morphology**
    - Flowability/Pack Density/Print Density
  - **Particle Sizing**
    - Flowability/Print Layer Thickness/Surfacing
  - **Chemical Composition**
    - Mechanical & Thermal Properties, Purity





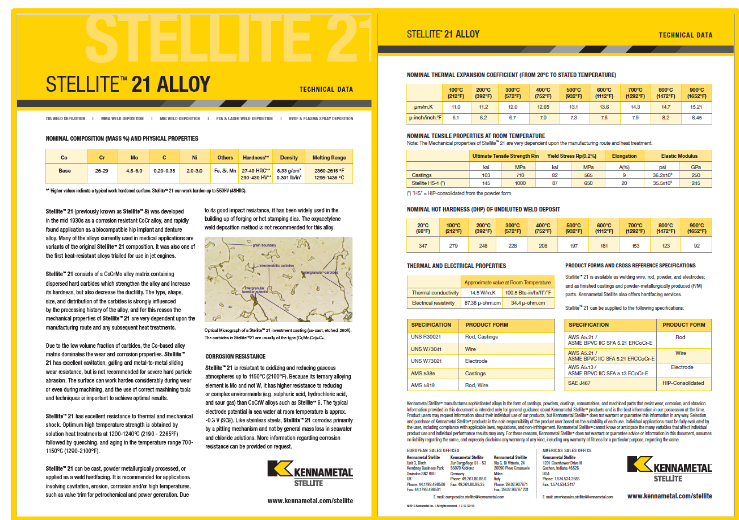
KMT Stellite - Today

Material	Alloy	Description	Application	
Cobalt	**Stellite 6**	**Co-Cr-W alloy with excellent resistance cavitation, corrosion, erosion, abrasion, and galling**	**Oil & Gas Cylinder Hardbanding via DED**	
	Stellite 21	**Co-Cr-Mo alloy with excellent high temperature strength, good wear and corrosion resistance**	**Dental Implants via PBF**	
Nickel	**Nistelle 625**	**Ni-Cr-Mo alloy with high corrosion and pitting resistance**	**Oil & Gas Production Component via PBF**	
	Nistelle 718	**Ni-Cr-Mo alloy with W and Co, high strength and corrosion resistance**	**Power Gen Part Development via PBF**	
Iron	**Delcrome 316L**	**Stainless steel consisting of Cr, Ni, and Mo, good toughness and corrosion resistance**	**Critical Valve Generation via PBF**	
	Delcrome 17-4	**Stainless steel containing of Cr and Ni, good hardness and corrosion resistance**	**Surgical Tooling via PBF**	
	Delcrome H13	**Tool Steel consisting of Cr and Mo, high toughness and wear resistant**	**Tooling Repair via DED**	

KMT Stellite - Looking to the Future

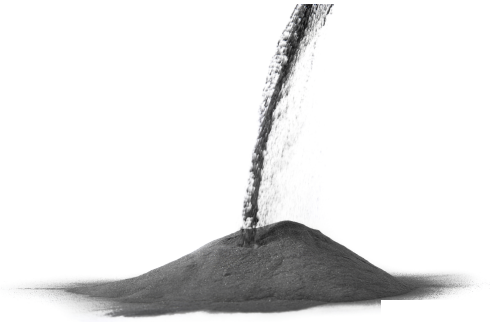
- Developing a portfolio of alloys for additive manufacturing applications

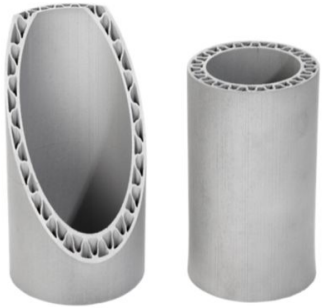
- Support customers with print/post-print data and recommendations

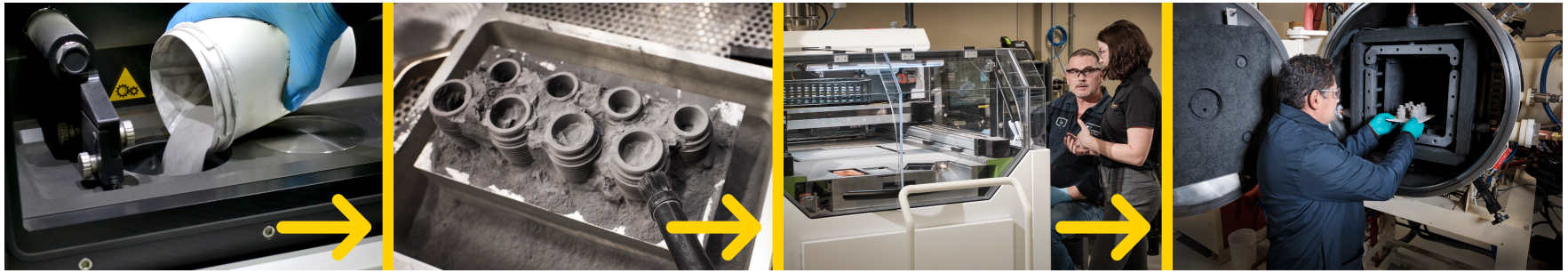


- Establishing partnerships with key AM users for material development

Complete Additive Solutions







Thank You!

Questions?

