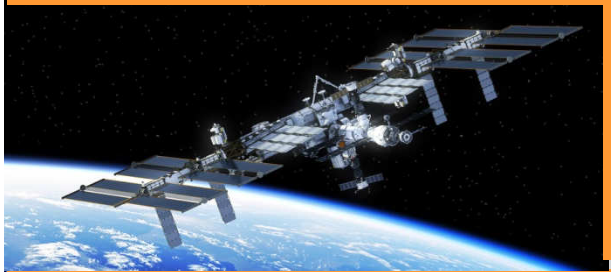
26 novembre 2019

WORKSHOP

LA QUALITÀ NELL'AEROSPACE"

Lo stato dell'arte e le sfide della Space Economy



aicq Associazione Italiana Cultura Qualità Settore Aerospace

In collaborazione con

ThalesAlenia Space a Thales / Leonardo company

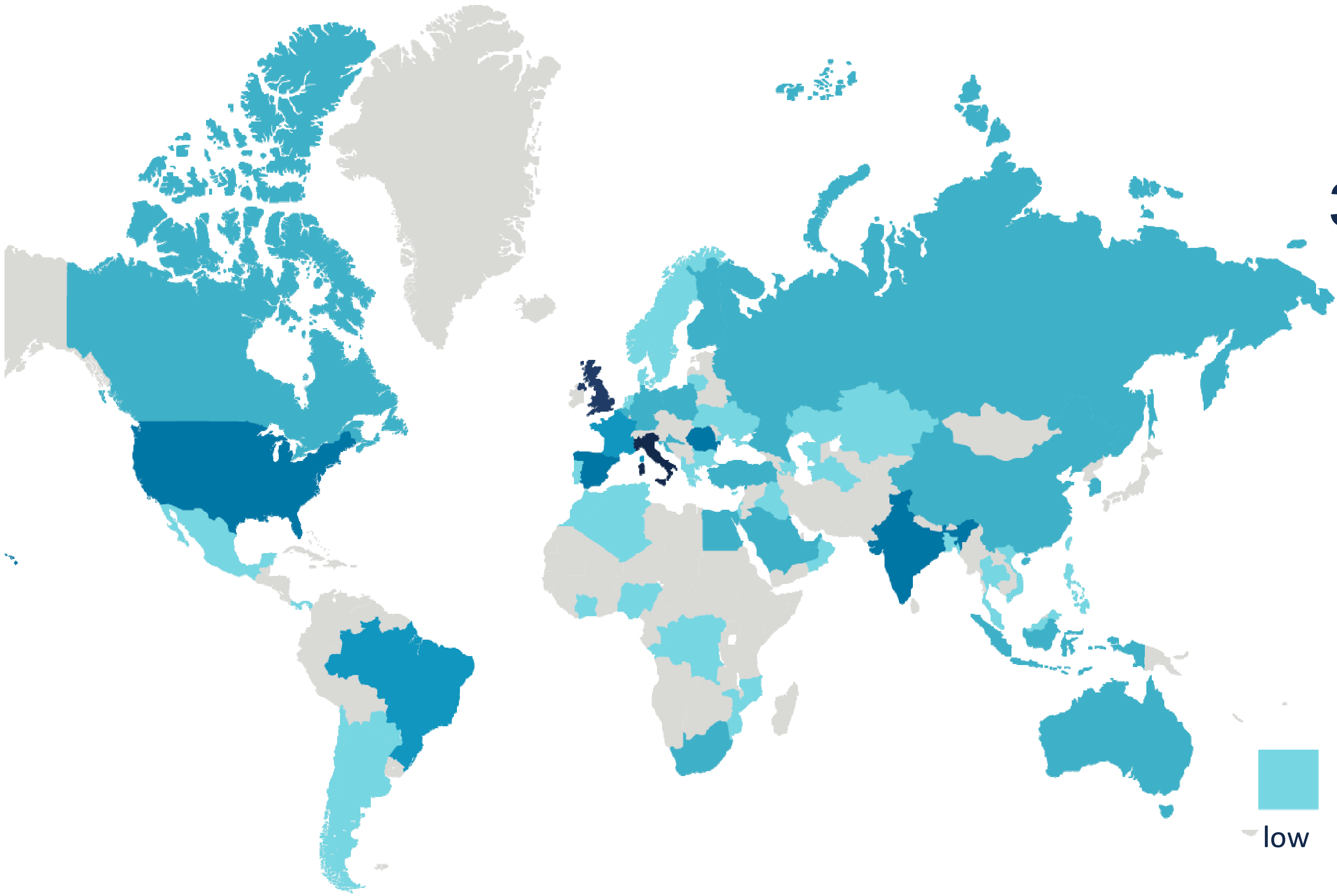
POLITECNICO DI TORINO

Dante Pocci

Rina Consulting- Centro Sviluppo Materiali S.p.A.

"La metallurgia delle polveri nell'Additive Manufacturing: aspetti di caratterizzazione e di certificazione per componentistica aerospaziale"

What is RINA today



3700 Colleagues

170+ Offices

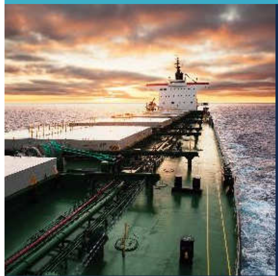
65+ Countries

LEVEL OF RINA PRESENCE:

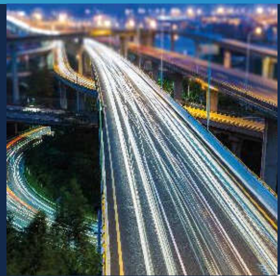
low → high

Our markets

SERVICES FOR ALL INDUSTRIES



Marine



Industry

Energy

Transport & Infrastructure

Certification

ISO e ASTM International indicano la struttura per produrre standard internazionali in ambito Additive Manufacturing

«ISO (International Organization for Standardization) e ASTM International (American Society for Testing and Materials) hanno realizzato congiuntamente la "**Additive Manufacturing Standards Development Structure",** ossia una struttura per lo sviluppo delle norme sulla manifattura additiva. Essa concorre a soddisfare l'esigenza di nuovi standard tecnici in questo settore in rapida crescita.

La nuova struttura creata da ISO e ASTM International per lo sviluppo di standard nel settore dell'Additive Manufacturing contribuisce a:

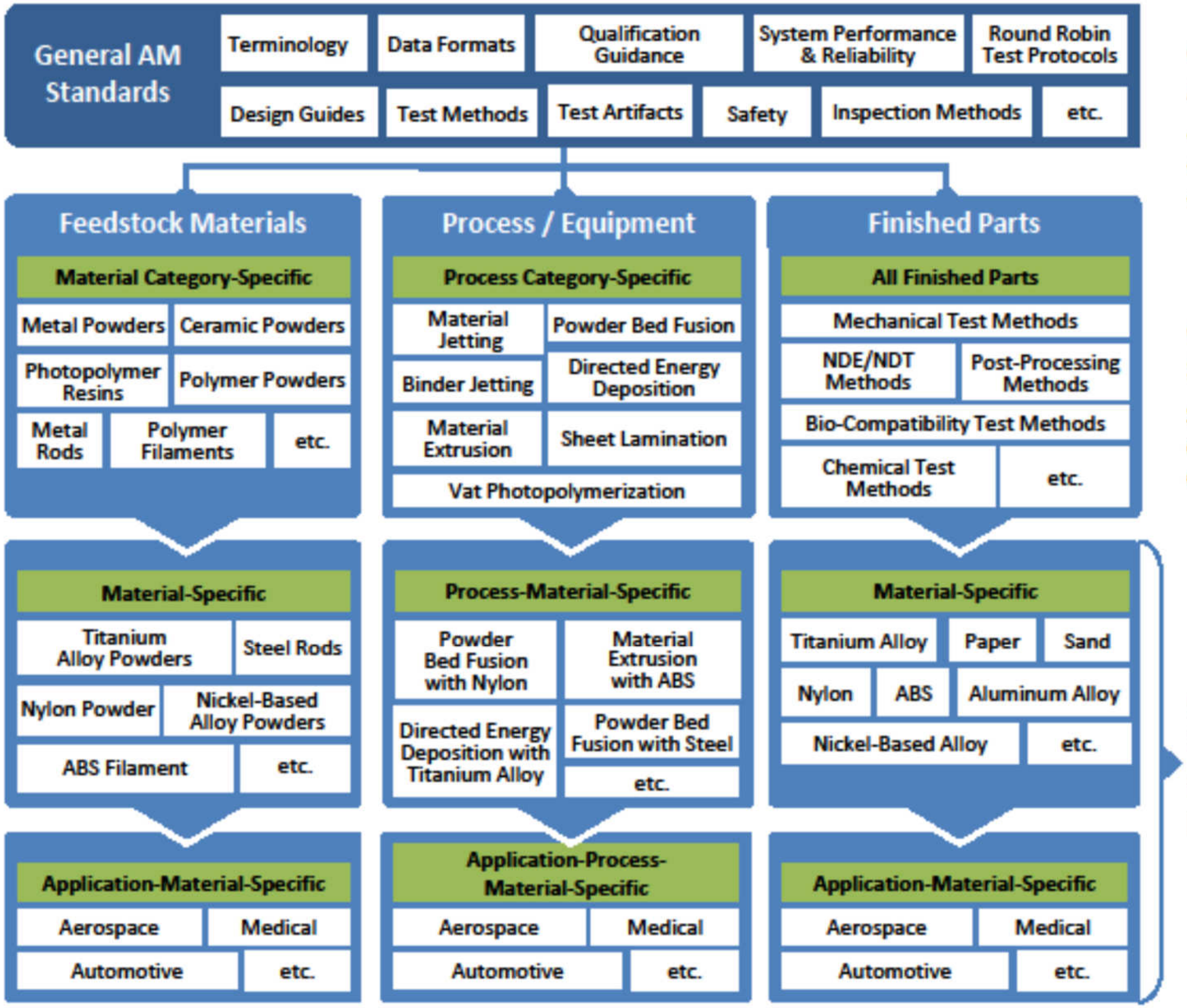
- indirizzare il lavoro di esperti ed organismi di normazione coinvolti nella standardizzazione del settore AM
- individuare **i vuoti normativi e le esigenze del settore AM**
- evitare le **sovrapposizioni e la duplicazione degli sforzi nello sviluppo degli standard AM**
- **garantire la coesione** tra le norme AM
- dare priorità agli ambiti degli standard AM
- **migliorare la fruibilità e l'accettazione** tra la comunità AM, compresi produttori, imprenditori, consumatori, ecc.

Sulla base del nuovo modello, gli standard sono sviluppati a 3 livelli:

- 1. **standard generali** (es. concetti, requisiti comuni, guide, sicurezza)
- 2. **norme per ampie categorie di materiali** (es. polveri metalliche) o processi (es. fusione a letto di polvere)
- 3. **standard specialistici per uno specifico materiale** (es. polveri di lega di alluminio), processo (es. estrusione con ABS) o applicazione (es. aerospaziale, medicale, automotive).

La nuova struttura è stata approvata nel mese di luglio 16, dalle commissioni tecniche di ISO ed ASTM International che si occupano della Manifattura Additiva, rispettivamente la commissione **F42 "Additive manufacturing technology"** e la **ISO/TC 261 "Additive Manufacturing**".

Additive Manufacturing Standards Structure



General Top-Level AM Standards

- General concepts
- Common requirements
- Generally applicable

Category AM Standards

Specific to material category or process category

Specialized AM Standards

Specific to material, process, or application

The Value chain: the key-role and the networking approach of RINA

- Alloy Design and Simulation
- Powder Metallurgy
- Bed Powder Systems
- Integrated Systems
- Metallurgy (Heat Treatment, Finishing, Defect Analysis, Stress)
- Tomography, On-line Monitoring
- Big Data + Digital
- Certification

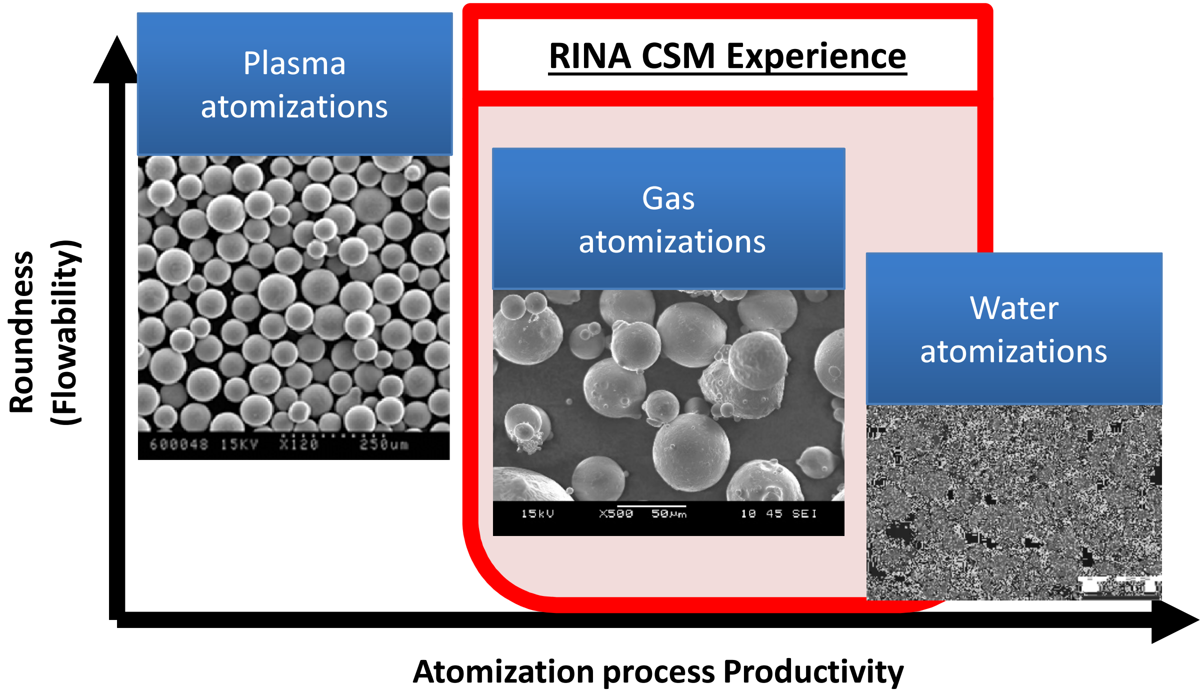
Internal Competences Development

Long Period Partnership

CSM Accreditations:
ISO 9001
ISO 9100
ISO/IEC 17025
ACHILLES

Metal powder Production

Different production methods lead to extremely different morphologies, shapes and particle sizes.

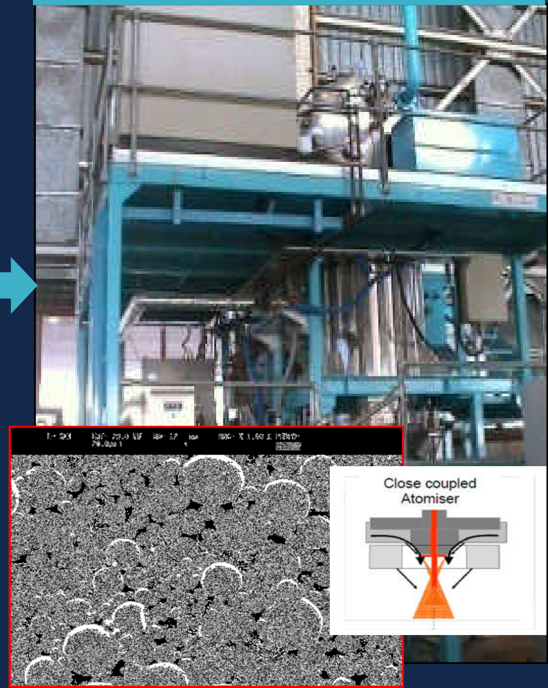


Metal powder Production

Relatively powder production, RINA with its VIGA plant (Vacuum Inert Gas Atomizer) have been **produced and developed** a significant amount of chemical compositions mainly of steels, superalloys, copper and aluminium alloys.

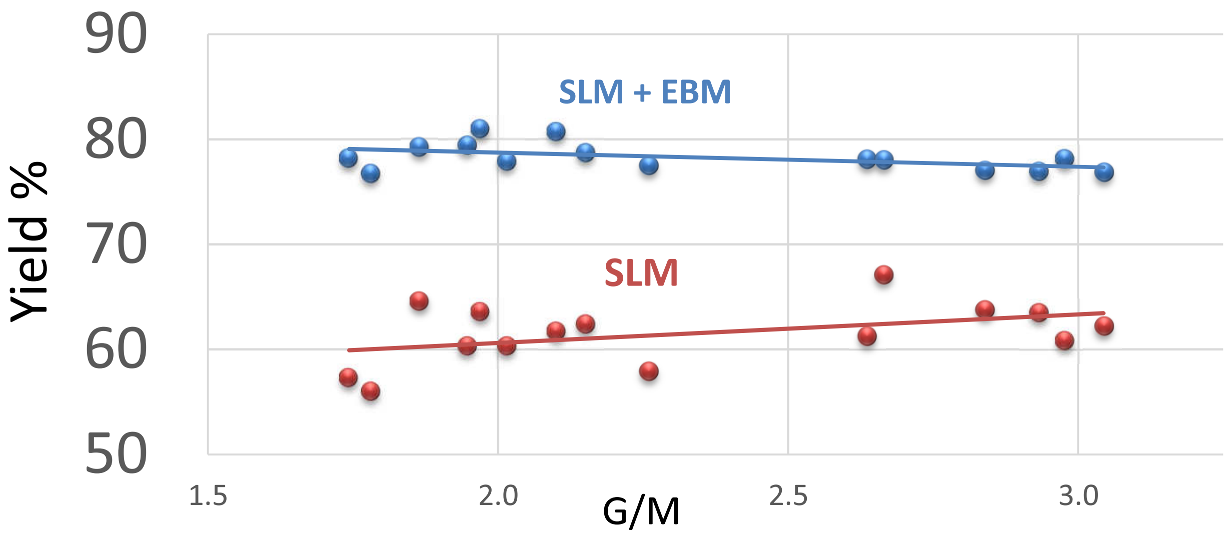
VACUUM INDUCTION MELTING

VACUUM INDUCTION GAS ATOMIZATION



Powder Manufacturing process optimization: G/M vs Yield

➢Different G/M ratio lead to similar final products, but with different efficency



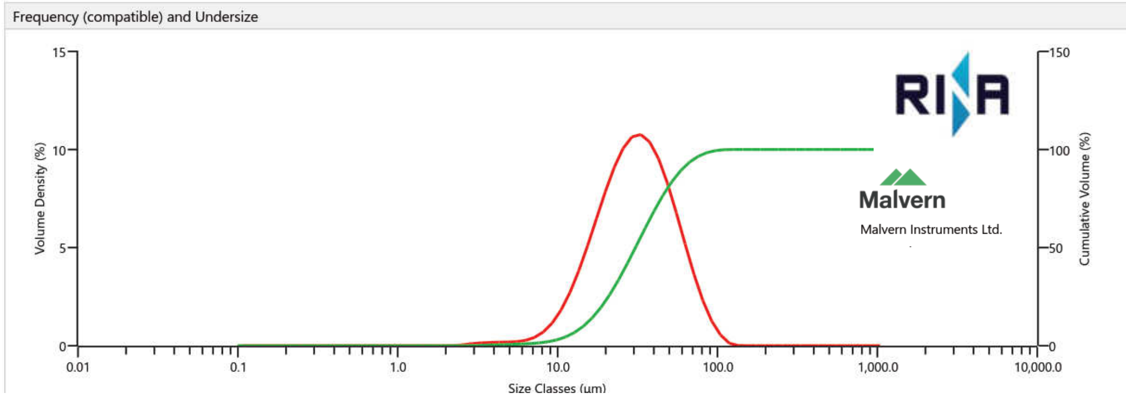
✓Selective Laser Melting (SLM)	15 - 65 µm
✓Electron Beam Melting (EBM)	50 - 100 µm

Metal powder Characterization

Analysis

- ❑ Chemical composition
- ❑ Particle size analysis
- ❑ Morphology by SEM
- ❑ Flow characteristics
- ❑ Tap & apparent density

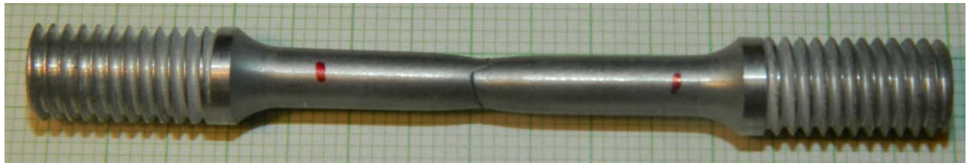
Particle size analysis

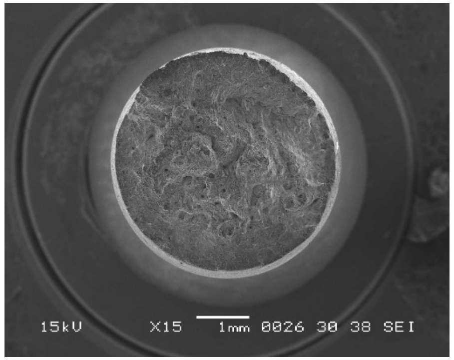


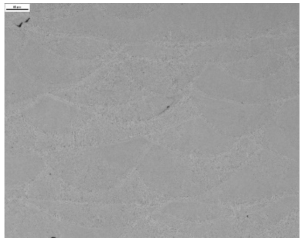
Details of mechanical characterization carried out for an industrial client

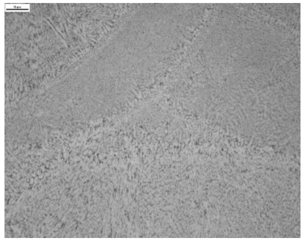
Type of test	Reference norms
Chemical Analysis	ISO 5832-3/ASTM F136/ASTM F3001 / DIN EN 1706 / EN AC 43000
Density	ASTM B923/ EN ISO 3369
Radiography	N.D.
Surface Flaw Detection	N.D.
Tensile test	EN ISO 6892-1/ASTM E8
Coefficient of Linear Thermal Expansion	TBD
Impact Test (Charpy)	EN ISO 148-1
Hardness	EN ISO 6506-1/EN ISO 6507-1
Fracture Toughness	ASTM E399/ASTM E1820
High Cycle Fatigue	ASTM E466/EN 6072
High Cycle Fatigue HiFrequency	ASTM E466/EN 6072
Metallography	TBD
Fractography	TBD

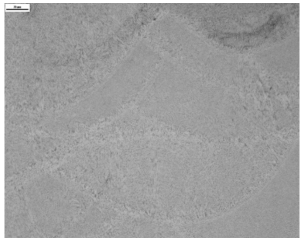
Details of mechanical characterization carried out



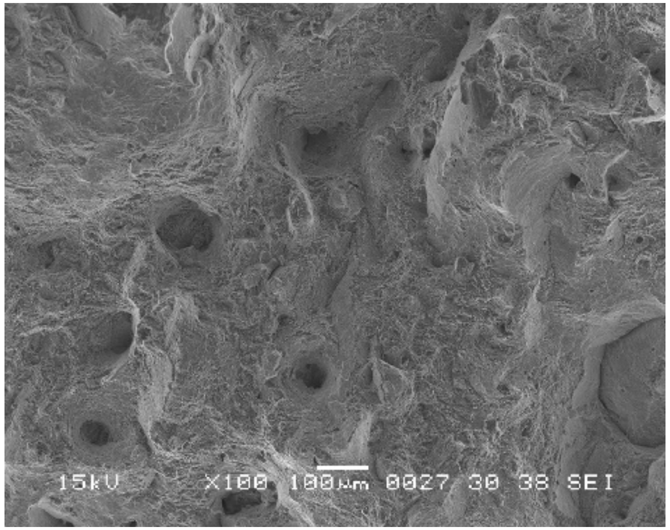


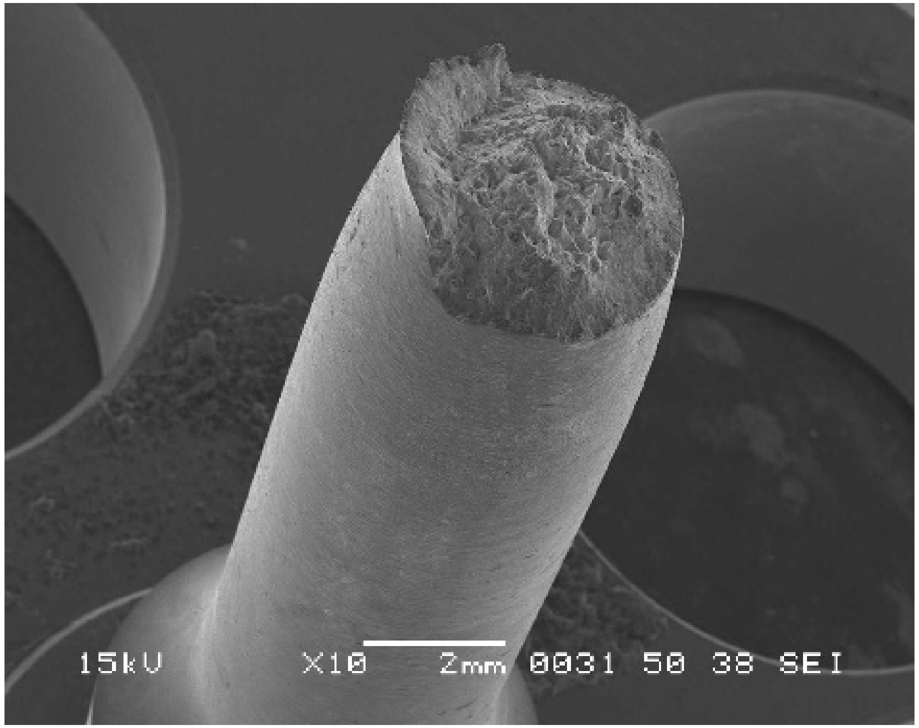




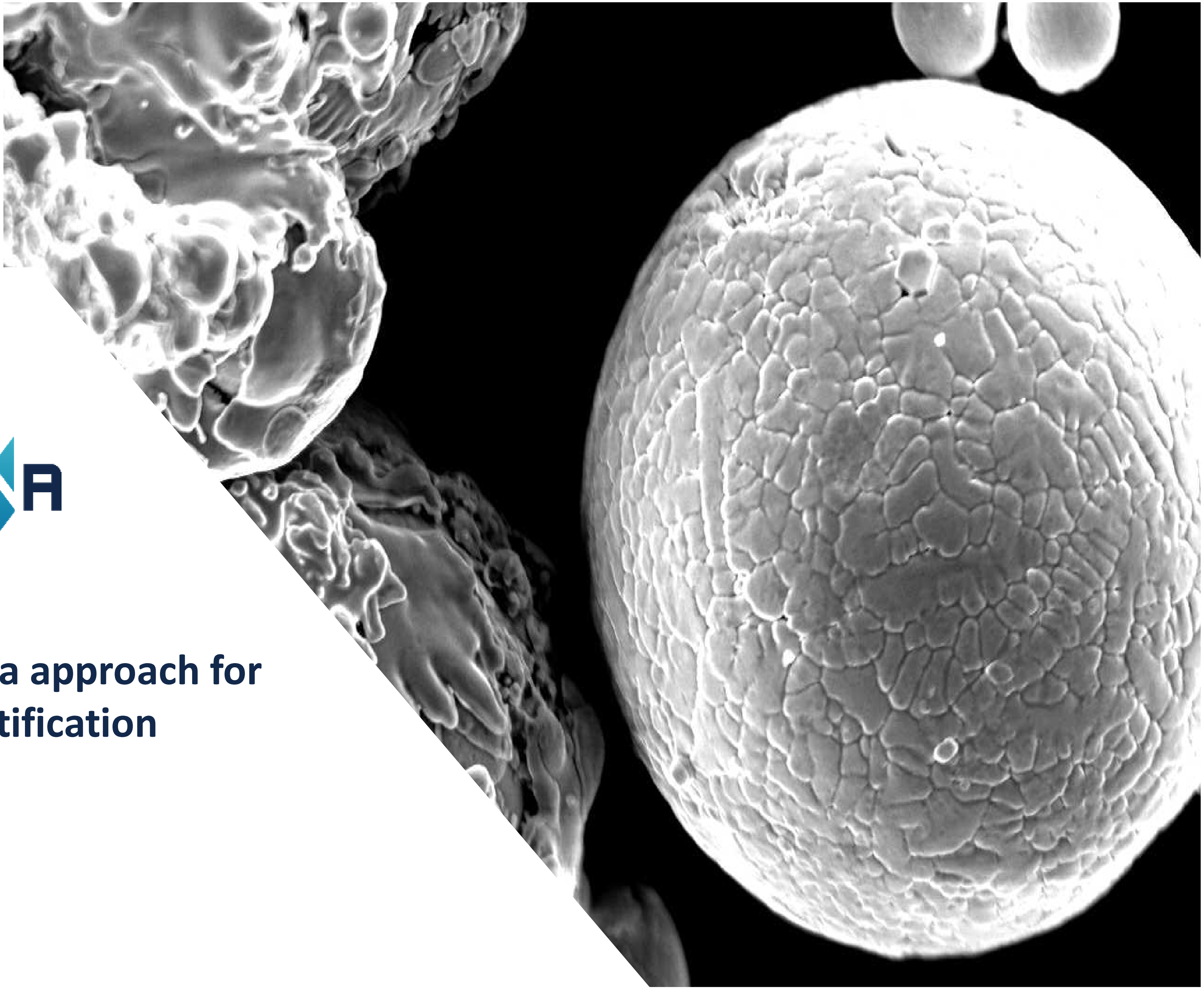


Details of mechanical characterization carried out





The goal is to establish a correlation between powder properties and results of mechanical testing



Rina approach for certification

AM and standardization

Standards are a **priority** for AM

- Strategic Research Agenda (AM platform)
- Standardization Roadmap for AM

Organizations active in standardization:

- ISO/TC 261
- ASTM - F42 commitee
- CEN/TC 438
- VDI/TC FA 105 (Germany)
- BSI Committee AMT/8 (UK)
- NEN committee 341107 (Netherlands)
- AFNOR group UNM 920 (France)

Guidelines

RINA: Guidelines for the certification of metallic parts made by additive manufacturing

5.4 Feedstock Material

Concerning the two previously described technologies, the feedstock material can be

either a powder or a wire. In both cases the properties of the feedstock are fundamental for

the fulfilment of the final properties on the component.

Powder feedstock

PBF processes use only this kind of feedstock and some **DED** processes can work either with powder or with wire feedstock.

RINA: Guidelines for the certification of metallic parts made by additive manufacturing

Powders properties to be verified are numerous and have different influence on the process.

Most relevant factors that play an important role and that have an effect on the **finished product** are:

- morphology;
- particle size distribution;
- density;
- porosity;
- thermal properties;
- surface properties;
- impurities.

RINA: Guidelines for the certification of metallic parts made by additive manufacturing

Guidelines for the certification of metallic products made by additive manufacturing

In detail powder for AM processes are usually produced by **atomization process.** This process allows to obtain spherical powders by melting the alloy and then pouring it through a nozzle were an inert gas impinge the molten metal. The metal is disrupted by the high pressure gas and molten droplets solidifies to obtain spherical particles. Powder characteristics are managed by acting on process parameters like gas pressure, melting temperature and more generally by regulating the gas to metal ratio.

Usually powders for AM require spherical shape, uniformity in size (narrow distribution) and full density (no holes). For these reasons gas atomization and plasma processes are the most commonly used processes to produce powders for AM since they are the best methods to obtain a good product. The granulometry of the powders is different according with the technology used: for example the EBM technology requires a powder size of 45-100 microns, while DMLS requires powder size of 30-45 microns.

RINA: Guidelines for the certification of metallic parts made by additive manufacturing

Defects on particles are directly responsible of the formation of defects in the building job.

Some examples of powder defects are **satellites, hollow powders, and particles with kissing** bonds (e.g. two particles hold together by a neck) which are all generated during the atomization phase.

An important topic for PBF technology is the **reuse of powders**: since in the process only a small quantity of powder is melted and used to build the component, the great part of powder in the machine can be reused for another batch. Reusing of powder must be carefully managed to be sure that powder characteristics are not subject to **change during multiple use.**