ArcelorMittal Powders

AdamIQ™ SAM 2

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LOW DENSITY, HIGH ENERGY ABSORPTION STEEL

Made from 100% recycled steel and renewable energy. Spherical, with high flowability and low level of impurities.

At ArcelorMittal we believe that Steel Additive Manufacturing can create new opportunities for all manufacturing sectors, providing complex, customised parts with superior properties, performance, and longevity. Let us take you through our vision for the future of Additive Manufacturing, a uniquely Steel perspective with our SAM products. Our latest product, AdamIQ™ SAM 2, exemplifies this commitment by providing a unique printable triplex steel with exceptional characteristics.

AdamIQ™ SAM 2 is designed to meet the demands of modern manufacturing sectors, offering a lower density that is 11% lighter than traditional steels. This reduction in weight does not compromise its strength or durability; instead, it enhances the material's ultra-high energy absorption capabilities, making it ideal for applications requiring robust performance under extreme conditions.

One of the standout features of AdamIQ™ SAM 2 is its cryogenic performance. The steel remains ductile down to temperatures as low as -70°C, transitioning to a brittle state only below this threshold. This property makes it suitable for use in environments where materials are subjected to severe cold, ensuring reliability and safety

AdamIQ™ SAM 2 has an austenitic microstructure, which ensures perfect homogeneity and robustness against variations in printing conditions. This microstructure is quite similar to 316L, but AdamIQ™ SAM 2 offers higher hardness, strength, and toughness, while maintaining similar elongation and a density that is 11% lower.

With its combination of low density, high energy absorption, and excellent cryogenic properties, AdamIQ™ SAM 2 is well-suited for lightweight structural, defense, automotive, aerospace, and railway applications.

The high levels of Al, provide good oxidation resistance, and samples keep the metallic shine at room temperature. So, no surface posttreatment is needed.
The robustness, appearance and versatility of 316L in as built conditions, the 11% weight saving and ultra high energy absorption on top.

Main characteristics	Markets
Good oxidation resistance	Defense
Great printability	Aerospace
Microstructural homogeneity	Railway
Low density	Automotive
High energy absorption	Structural

Powder properties

Chemical composition in weight (%) [1]

Iron	Balance
Manganese	26.0 - 29.0
Aluminum[4]	6.0 – 7.5
Chromium[4]	< 2.50
Silicon[4]	< 0.5
Carbon	0.7 - 0.9
Nitrogen	< 0.10
Boron[4]	< 0.10
Phosphorus	< 0.02
Sulphur	< 0.02

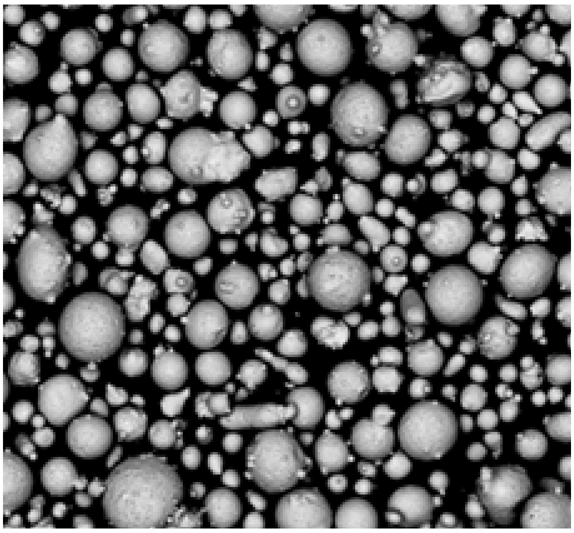
Physical test data

Nominal particle range	20-53 µm
Apparent density[2]	3.9 g /cm³
Hall Flow[3]	< 20 s / 50g
Skeletal Density[5]	7.0 g /cm³

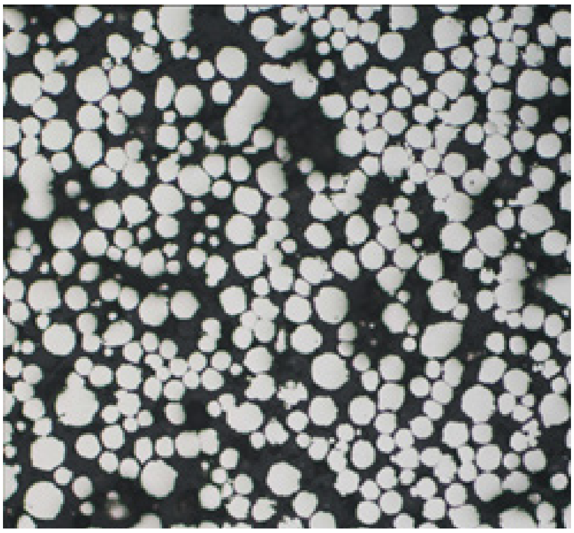
Also available in particle sizes:
• Less than 20 microns for Binder Jetting (BJT), Metal Injection Molding (MIM) or specific processes targeting very thin walls.
• 53-105 microns typically for Electron Beam Melting (EBM, E-PBF) and Laser Metal Deposition (LMD).
• Specific sizing can be considered under conditions.

1. Patent pending
2. Apparent density according to ASTM B212
3. Hall Flow according to ASTM B213
4. Optionally containing, and/or one or more elements chosen among Ta, Zr, Nb, V, Ti, Mo, and W in a cumulated amount of up to 2.00 wt.%
5. Skeletal density according to ASTM B923

Powder morphology



SEM image AdamIQ™ SAM 2 20-53 µm



LOM image AdamIQ™ SAM 2 20-53 µm

Microstructure

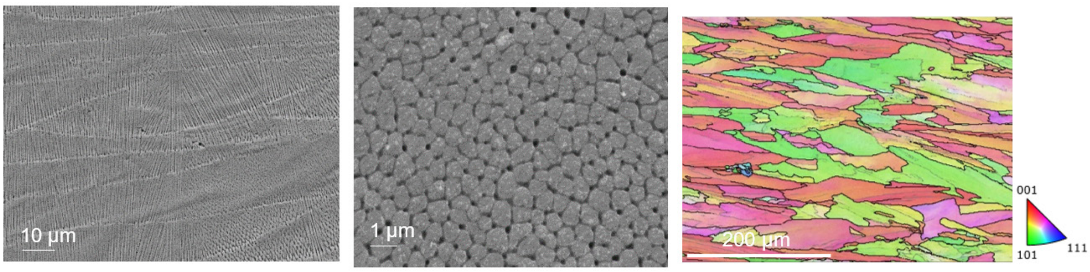


Fig. 1 SEM representative micrographs at different magnifications of AdamIQ™ SAM 2microstructure As-Built printed in L-PBF and EBSD map.

The chemical composition profile along different grains cross-section was measured precisely using STEM data, indicating a homogeneous distribution throughout the sample. Minor variations in the Mn content were detected, confirming the microstructural and chemical composition uniformity of the steel in its as-printed condition.

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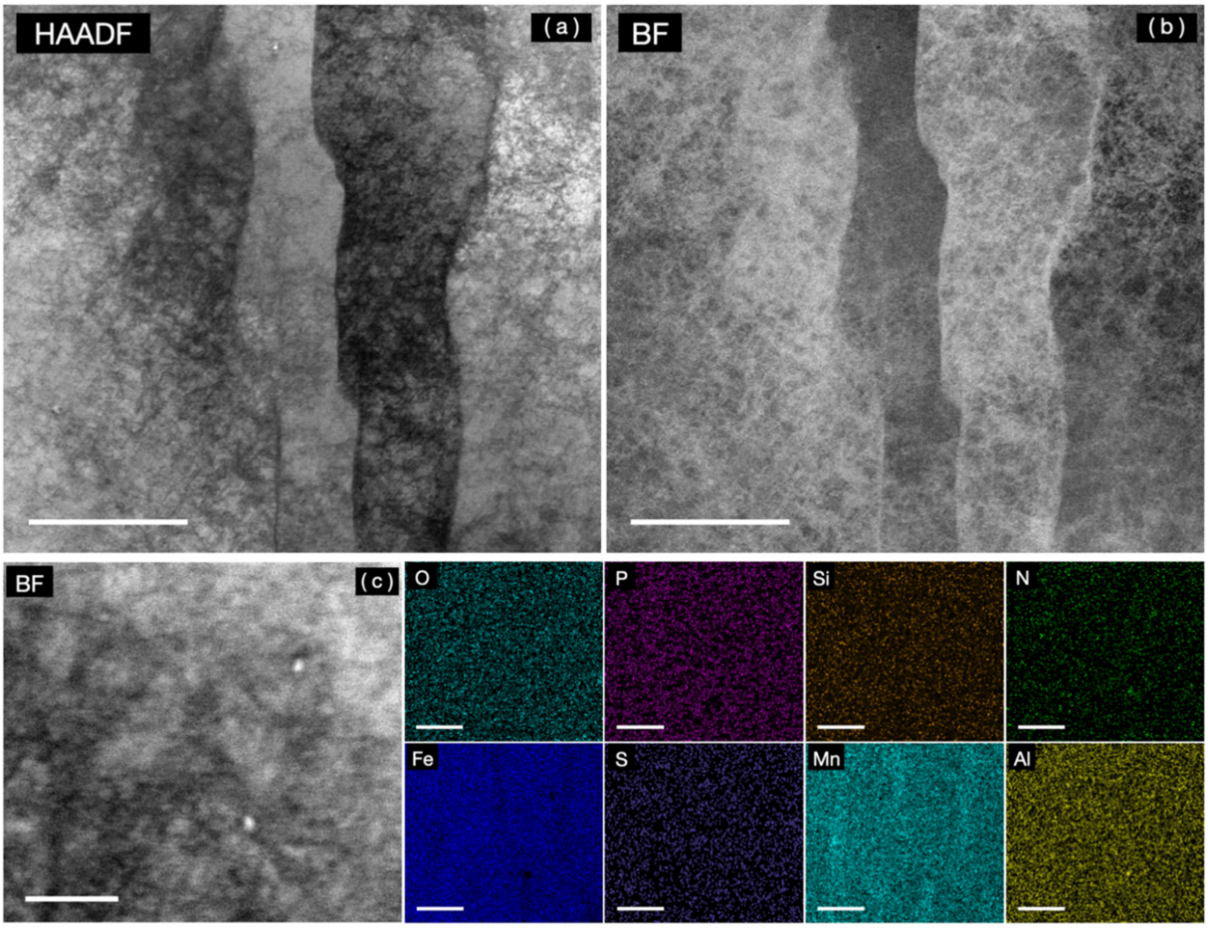

Fig. 2 shows STEM data from FIB-cut sections of the as-printed Triplex sample. (a) and (b) display lower magnification HAADF and BF images from the same area; (c) includes a BF image and a corresponding set of normalized X-ray intensity maps from an EDXS spectrum imaging experiment on a smaller area. The scale bars in (a) and (b) represent 1 µm, and those in (c) represent 500 nm.

Microhardness measurements were performed on a 1.5 x 1.5 mm² area of the cross-section, with over 600 indentations applied at a 100 g load, to analyze local variations that correlate with microstructural changes. The average hardness value obtained is 311 ± 9 HV.

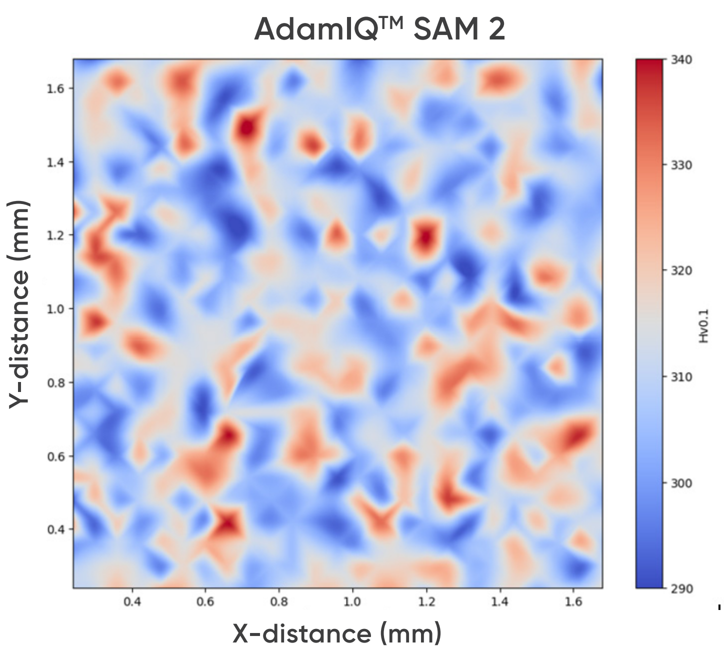

Fig. 3 Hardness mapping of an area of 1.5 x 1.5 mm2.

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Mechanical properties As-Built

	Yield Strength $R_{p0.2}$ [Mpa]	Tensile Strength R_m [Mpa]	ElongationA [%]	Hardness HV10
Vertical	620	793	40	301
Horizontal	735	957	30	-

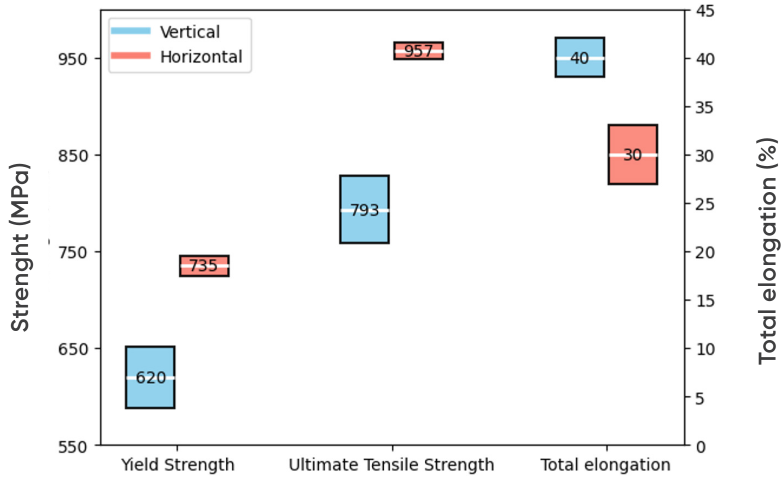

Fig. 4 Tensile properties As-Built of AdamIQ™ SAM 2 measured at vertical and horizontal directions

	Impact Energy at -196 °C [J]	Impact Energy at -60 °C [J]	Impact Energy at 20 °C [J]
Vertical	13	26	34
Horizontal	19	36	43

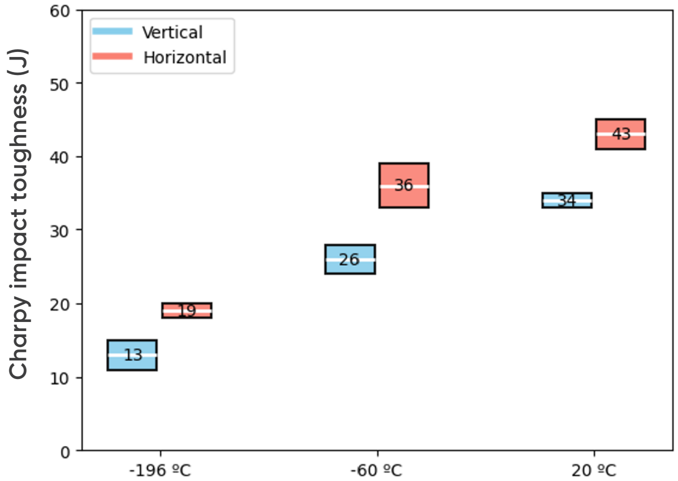

Fig. 5 Charpy V-notch impact toughness of AdamIQ™ SAM 2 measured at vertical and horizontal directions at room (20 °C) and low temperatures (-60 and -196 °C).

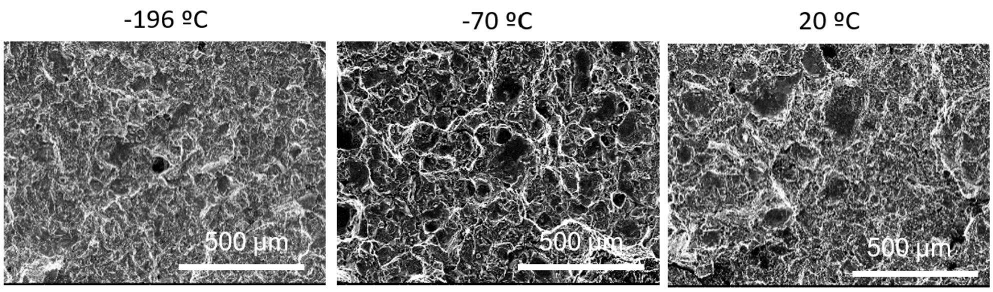

Fig. 6 Fracture Surface at different temperatures, showing that the main deformation mechanism is still ductile characterized by the nucleation, coalescence, and development of micro-holes.

The representative micrographs indicate that the primary deformation mechanism, even at cryogenic temperatures, remains ductile.

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Energy absorption

The energy absorbed by compressed materials was studied using lattice structures, ideal for Additive Manufacturing due to their complex fabrication. These structures were optimized to reduce weight and increase energy absorption during compression by retracting upon impact.

The highest performance was observed in a Double Diamond lattice structure with a total density of 30%, indicating that only 30% of the total volume (a 30 mm-sided cube) was occupied by metal. These lattice structures were tested under compression and compared to 316L.

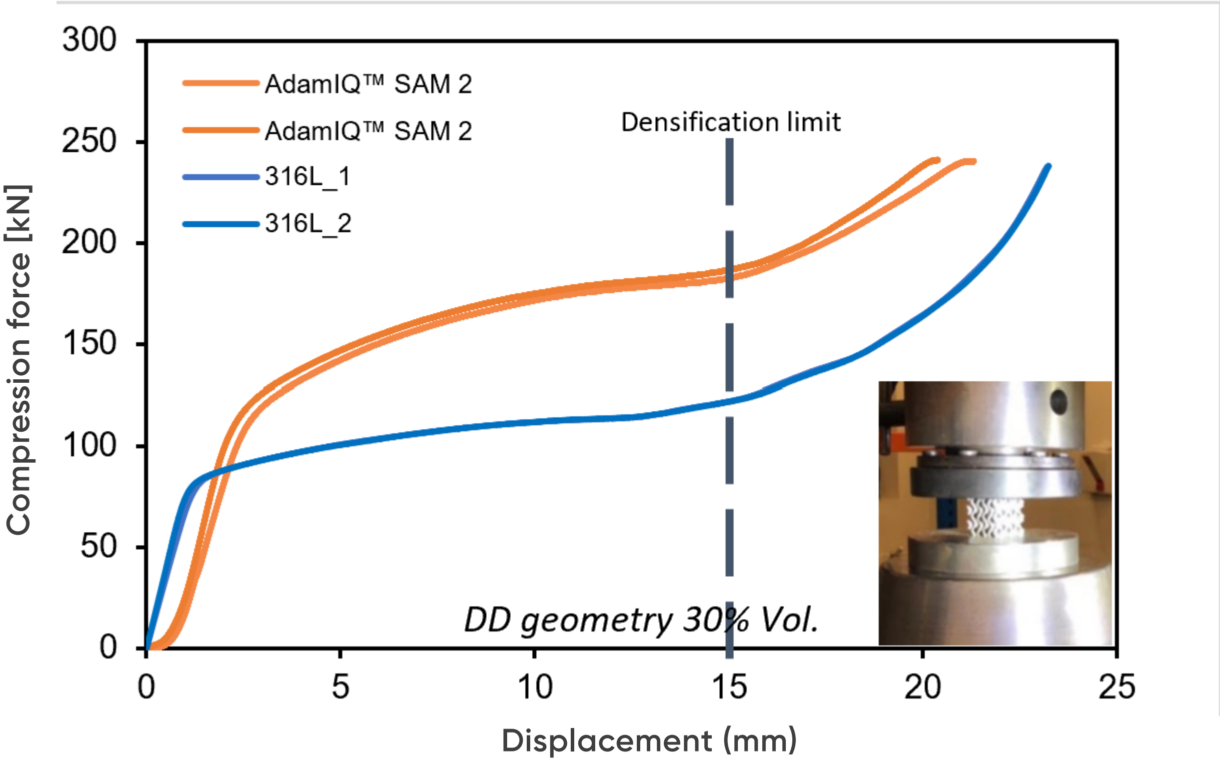

Fig. 7 Compression tests in lattices structures with double diamond geometry with 30% volume of AdamIQ™ SAM 2 Vs 316L

The response of AdamIQ™ SAM 2 is depicted in orange, whereas 316L is illustrated in blue. The energy absorbed is represented by the area under the curve up to the densification limit, where a slope change signifies the onset of lattice structure failure and collapse. The absorbed energy for 316L reached 1500 J, while AdamIQ™ SAM 2 absorbed 2400 J, indicating a 60% increase. When considering specific energy absorption, the relative improvement is even more significant, with 316L at 69 J/g and AdamIQ™ SAM 2 at 128 J/g, reflecting an enhancement of 85.5%.

Contact us to know how we can assist your production.

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e-mail us at **contact.powders@arcelormittal.com**
to talk to our experts.

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ArcelorMittal Powders, S.L.
C/ Las Rederas, 10
33490. Avilés, Asturias. Spain