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**DIPARTIMENTO DI MECCANICA**
Department of Mechanical Engineering

# Multi-materials by AM: opportunities and challenges
# AM di componenti multi-materiale: le opportunità e le sfide

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# *What are we talking about?*

AM is well appreciated for the feeedom in shape design, now we are adding more freedom in material choice within one single component according to the idea of multi-material (MM)

Joining different alloys with distinct properties in specific volumes of the same part

- ✓ mechanical strength + corrosion resistance
- ✓ thermal conductivity + creep strength
- ✓ mechanical strength + wear resistance
- ✓ …

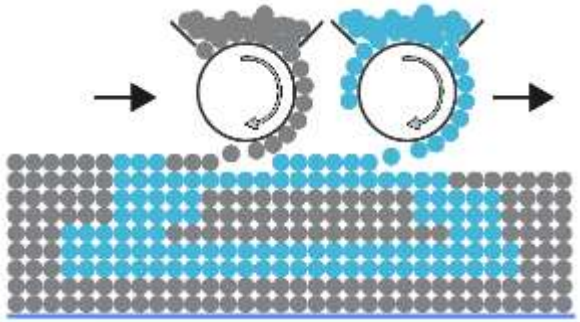
*Courtesy Aerosint Belgium*


*Courtesy Fraunhofer IGCV*

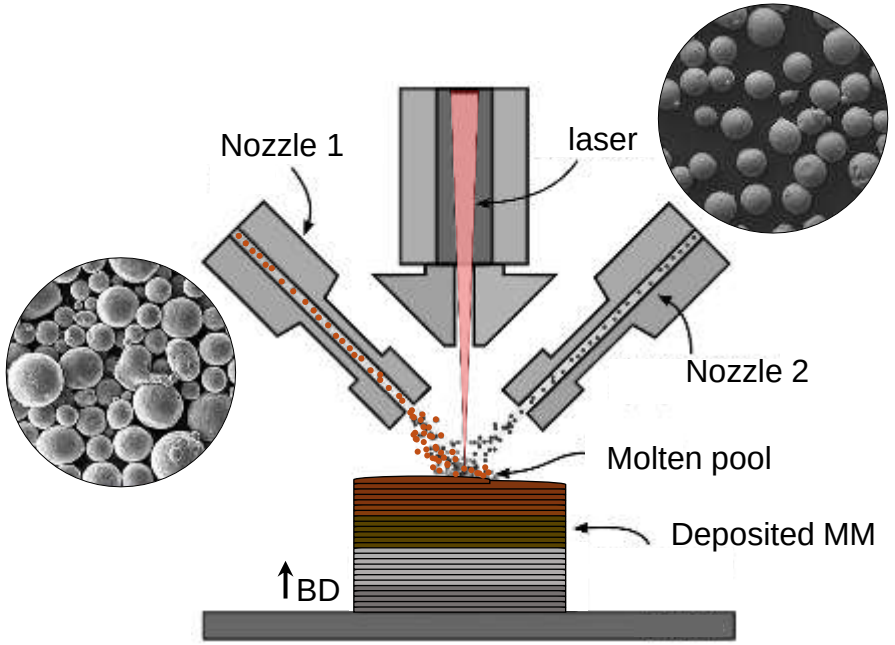
# *Which technologies for MM?*

For widespread diffusion and degree of maturity, LPBF and DED appear as the most promising processing routes

- ✓ Commercial systems are available



*Selected Powder Deposition patented by Aerosint*

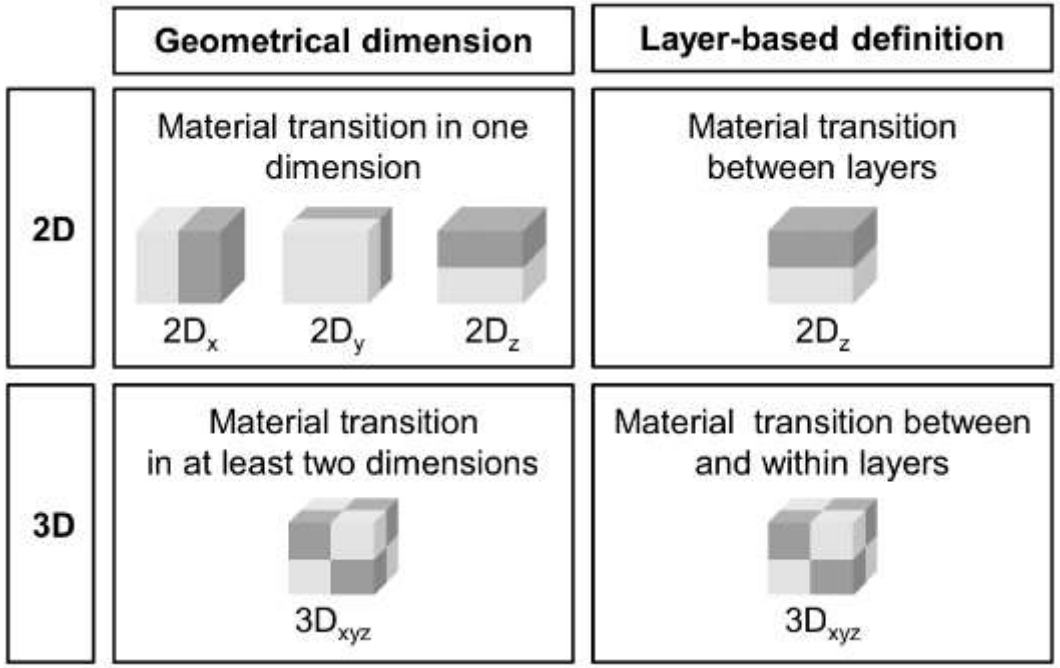



*Standard DED laser torch equipped with two powder delivery systems*

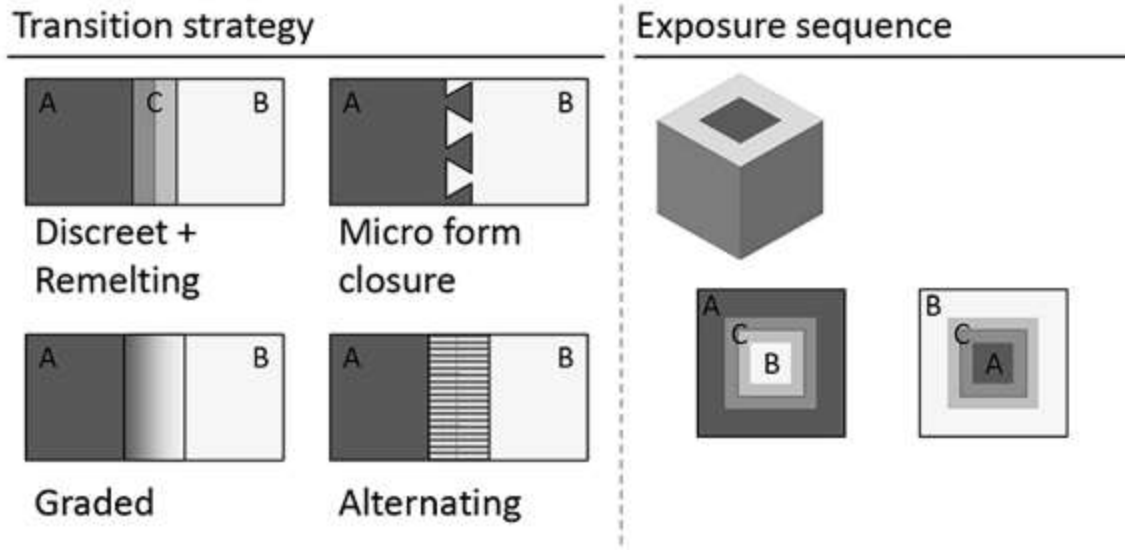
# *Options for the generation of MM systems*

Different strategies can be devised to design MM systems

- ✓ Material transition can be produced in 2D or 3D, between layers or even within layers
- ✓ The interface properties represent an important issue to be controlled



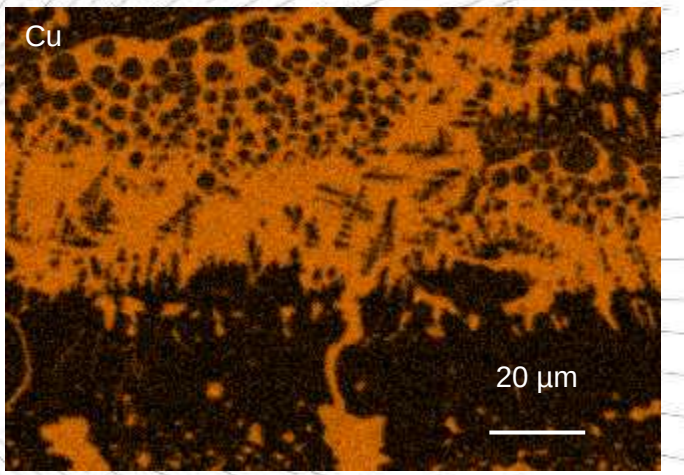

*M.Schneck et al. Progress in Additive Manufacturing (2021)*

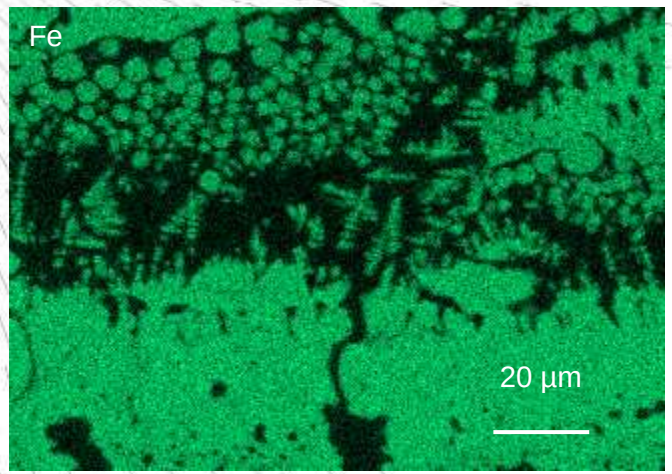


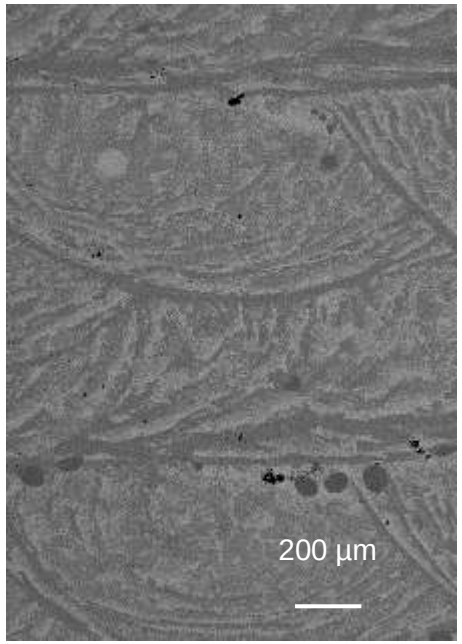

*www.metal-am.com/articles/multi-material-metalparts-by-powder-bed-fusion-new-application-opportunities/*

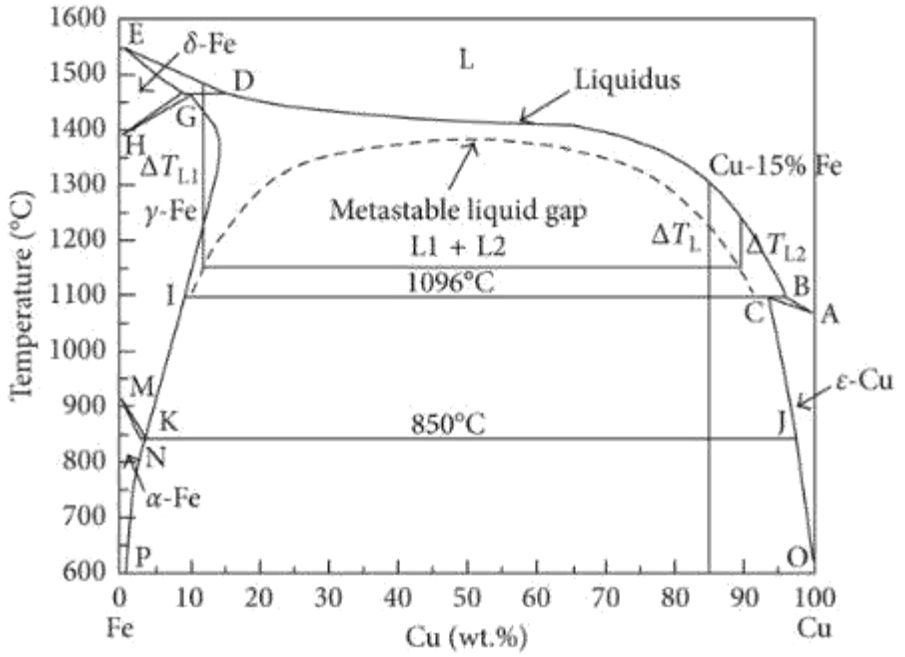
# *Few examples based on experimental activities at PoliMi*
## *Cu – 4130 steel samples produced by DED*

A first example for the matching of two materials that are almost immiscible, with a wide gap in laser reflectivity



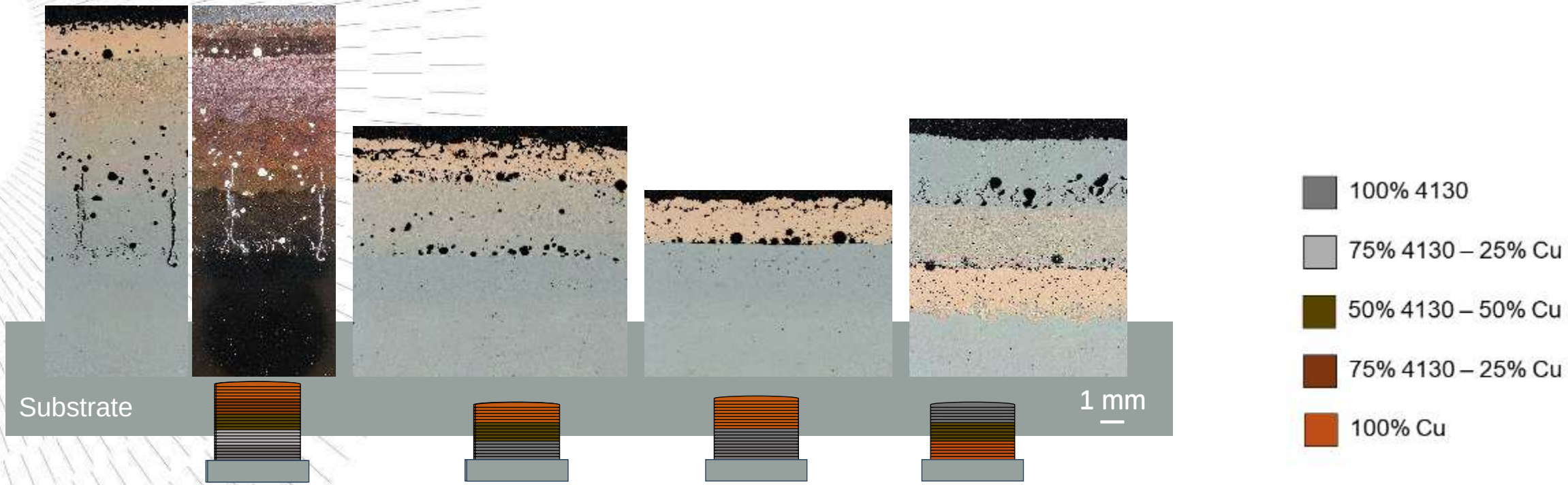



# *Few examples based on experimental activities at PoliMi*
## *Cu – 4130 steel samples produced by DED*

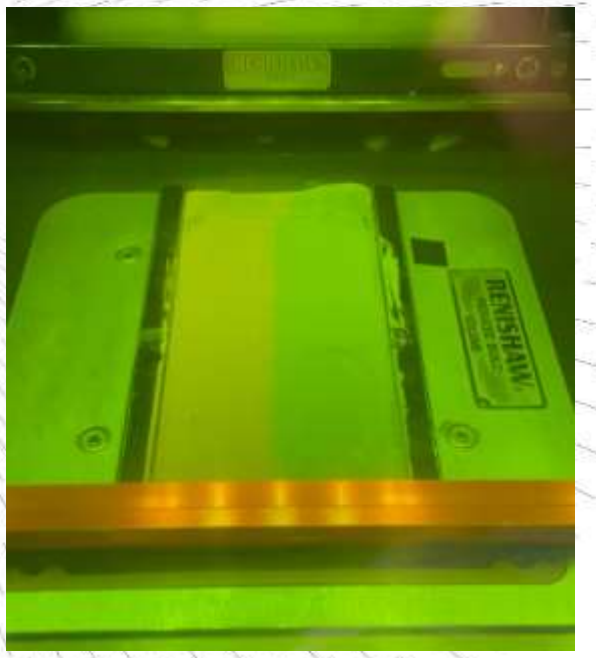
Some lessons learned

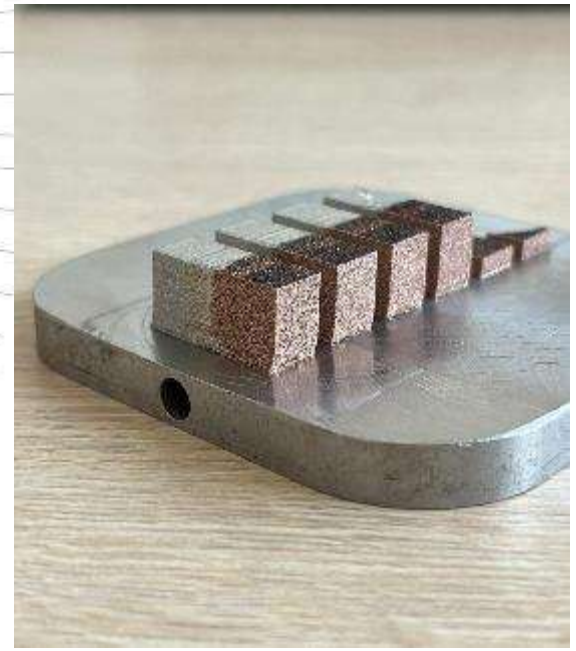
- ✓ Technological issues related to the shift from one material to another should be adjusted
- ✓ Most af the alloy mixtures are well printable, but 25%Cu-75% 4130 shows hot cracks
- ✓ Interfaces are not of particular concern for this system

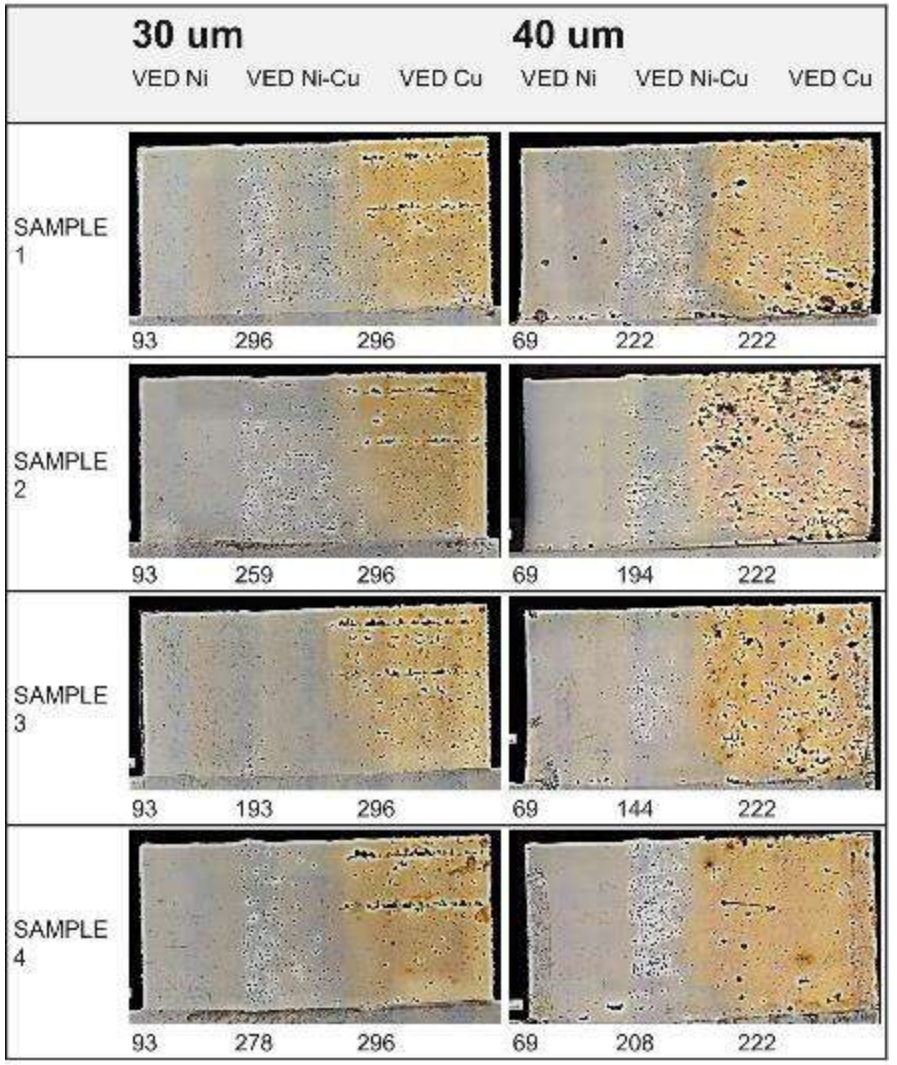


# *Few examples based on experimental activities at PoliMi*
## *CuNiSiCr2 – IN627 samples produced by LPBF*

- ✓ These two alloys are well soluble at liquid and solid stages
- ✓ The focus was mainly on interface generation and related properties
- ✓ Testing of tailored parameters in the intermediate region

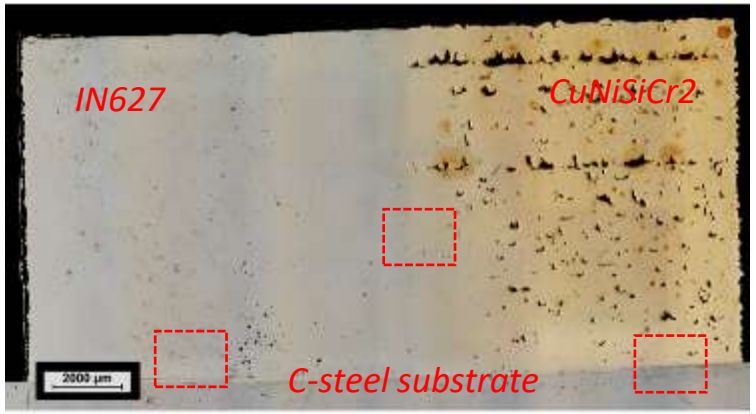


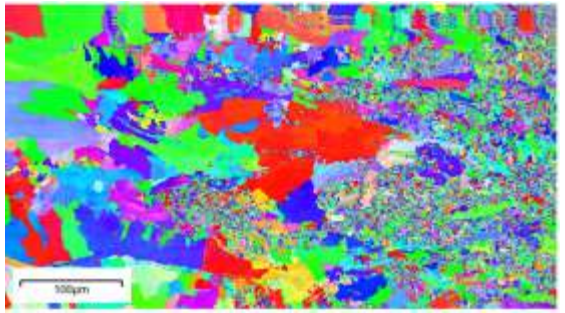



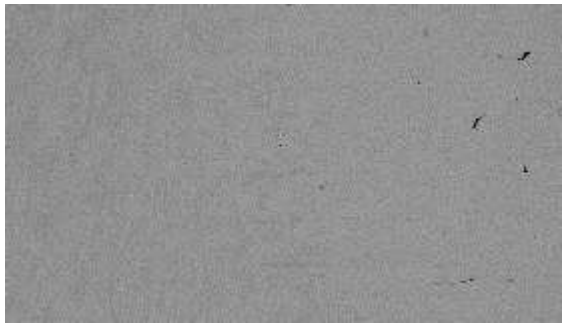


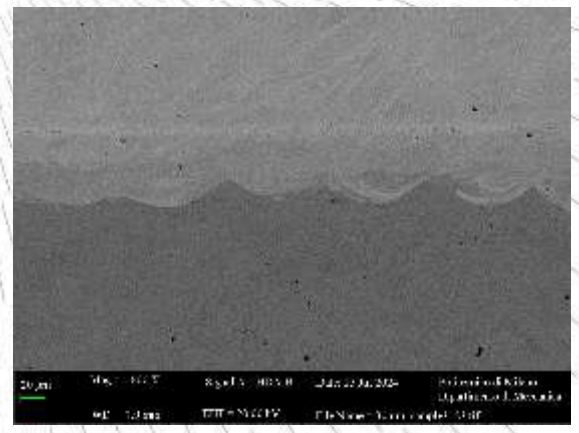
# *Few examples based on experimental activities at PoliMi*
# *CuNiSiCr2 – IN627 samples produced by LPBF*

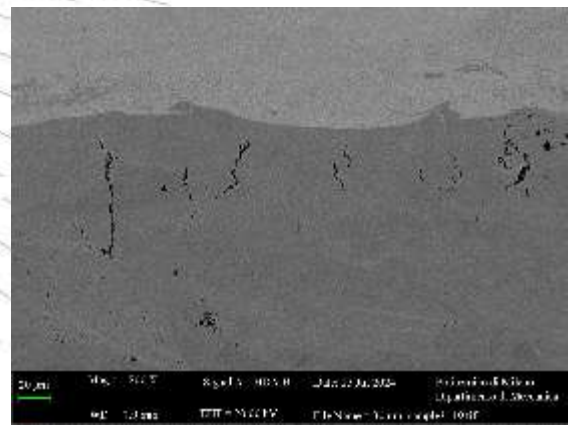
- ✓ CuNiSiCr2 – IN627 (both as melted powders)
- ✓ CuNiSiCr2 powder on C-steel building plate
- ✓ IN627 powder on C-steel building plate

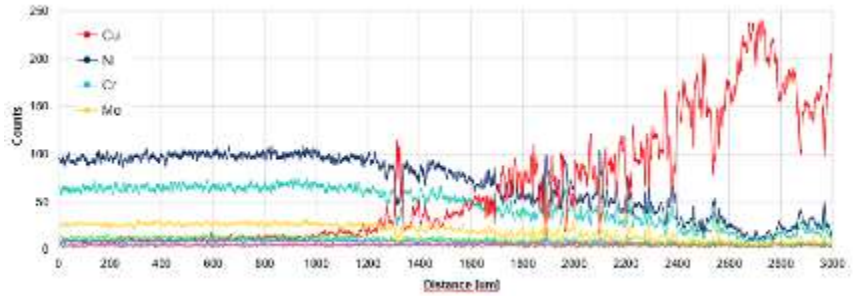










# *Final remarks & open issues*

To fully exploit the «free» design using AM and MM, one needs to bear in mind a number of issues and practical constraints requiring due consideration:

- ✓ CAD sw to prepare the model need to be updated to manage material changes
- ✓ Process parameters need to be optimized for each material and for the mixed interfaces as well
- ✓ Scanning strategies require more constraints to match the position of interfaces
- ✓ Management of residual stresses may become more challenging when dealing with alloys featuring different properties
- ✓ Post-process thermal treatments should be effective for both alloys
- ✓ Powder recycling is an issue of great concern

But the potential advantages achievable by a proper use of MM for special parts are undoubtedly exciting and worthy of the large efforts currently devoted worldwide on this research topic

# *Thanks for your kind attention!*

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