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# Elaboration of oxide dispersion strengthened Fe-14Cr steel by selective laser melting : a new route for new applications

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## Context

**Oxide Dispersion Strengthened (ODS) stainless steels** are being considered as materials for fast breeder reactor, an application that requires a **low swelling rate and high creep strength** in the temperature range of 400 – 800°C. Conventional processing techniques, which involve melting such as foundry, tend to be avoided to produce ODS alloys since oxide particles can slag off into the molten pool which is detrimental for alloys creep strength. That is why ODS materials are **usually produced by powder metallurgical process** :

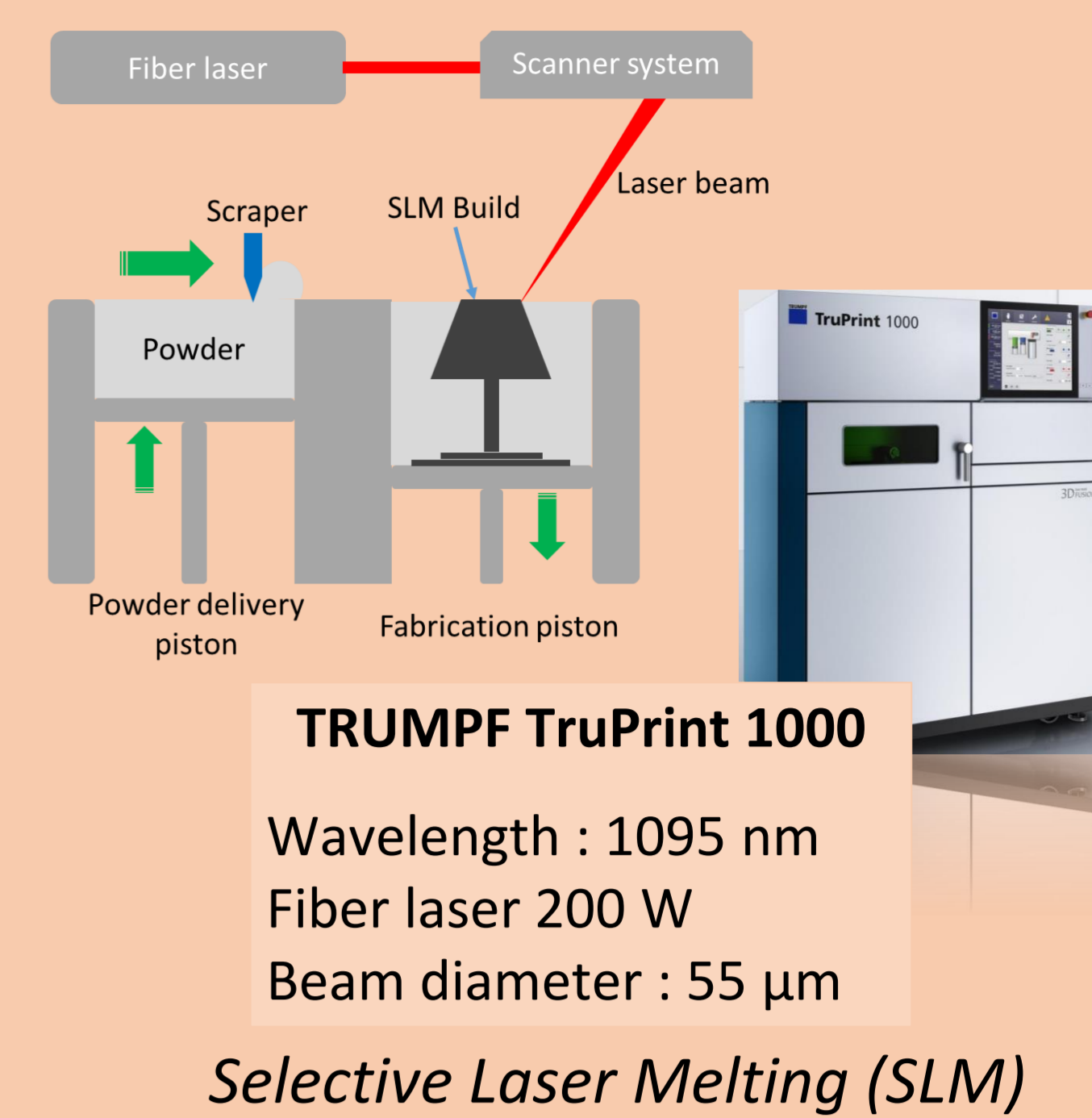


Mill steel powder with oxides powder  
 Aim : Insertion of Y, Ti and O atoms in solution solid

3 → **Main objective** : generate fine dispersion of precipitates inside the material to increase creep resistance

Conventional route : Consolidation of the powder by hot extrusion or hot Isostatic Pressing  
**Limitation in final shape of materials**

In this work : Consolidation of the powder by selective laser melting  
**Overcome design limitations**

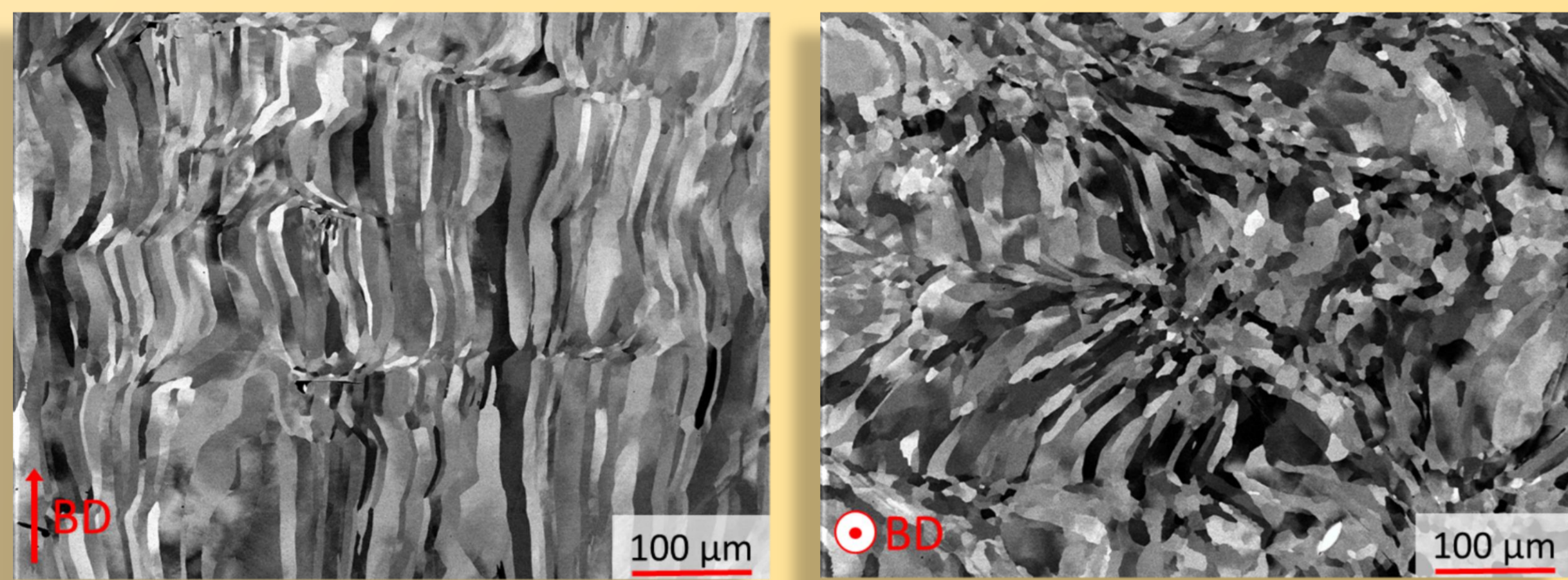


## Objectives

- Study the potentialities of Selective Laser Melting (SLM) for the OS complex parts manufacturing
- Understand how process parameters tailor the microstructure and mechanical properties

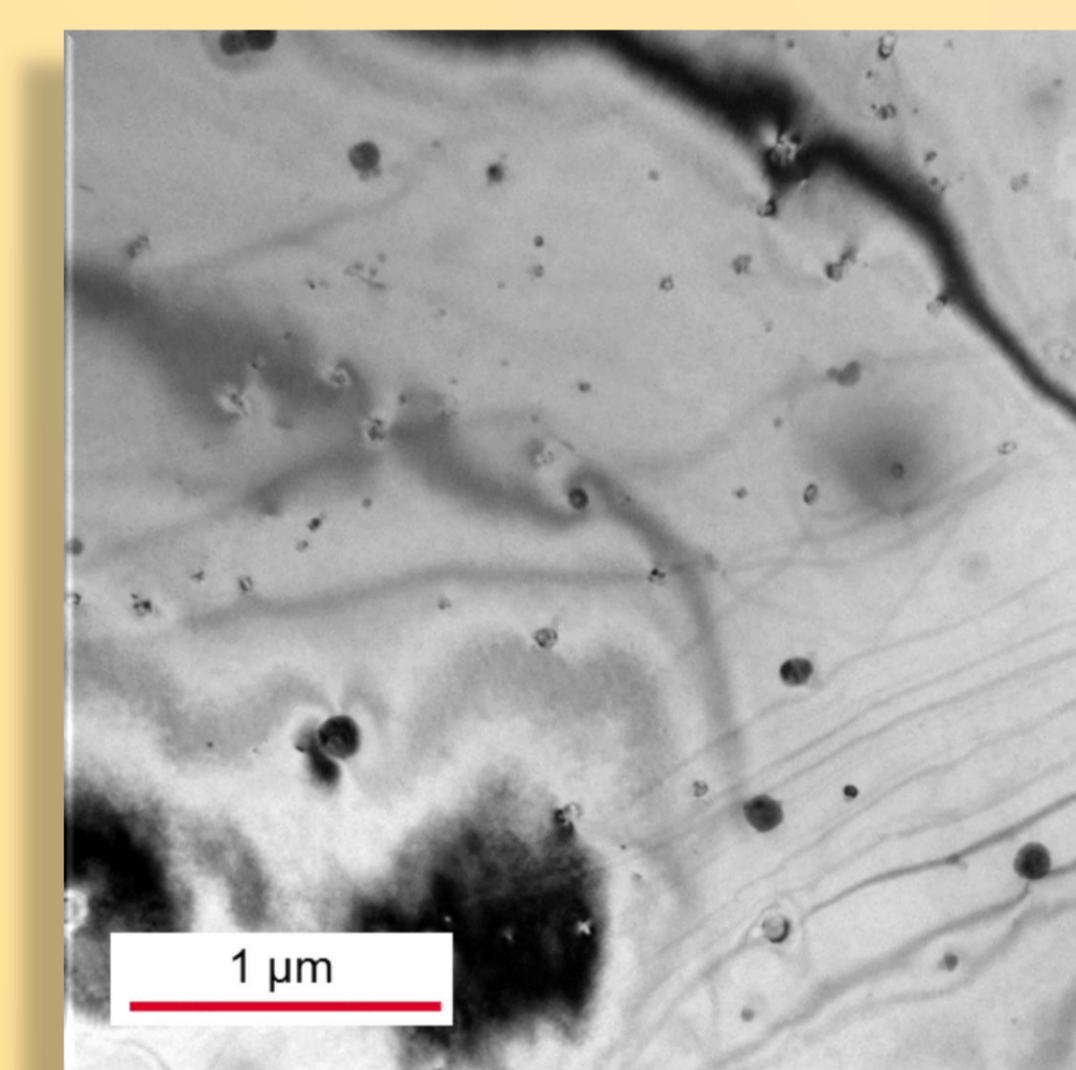
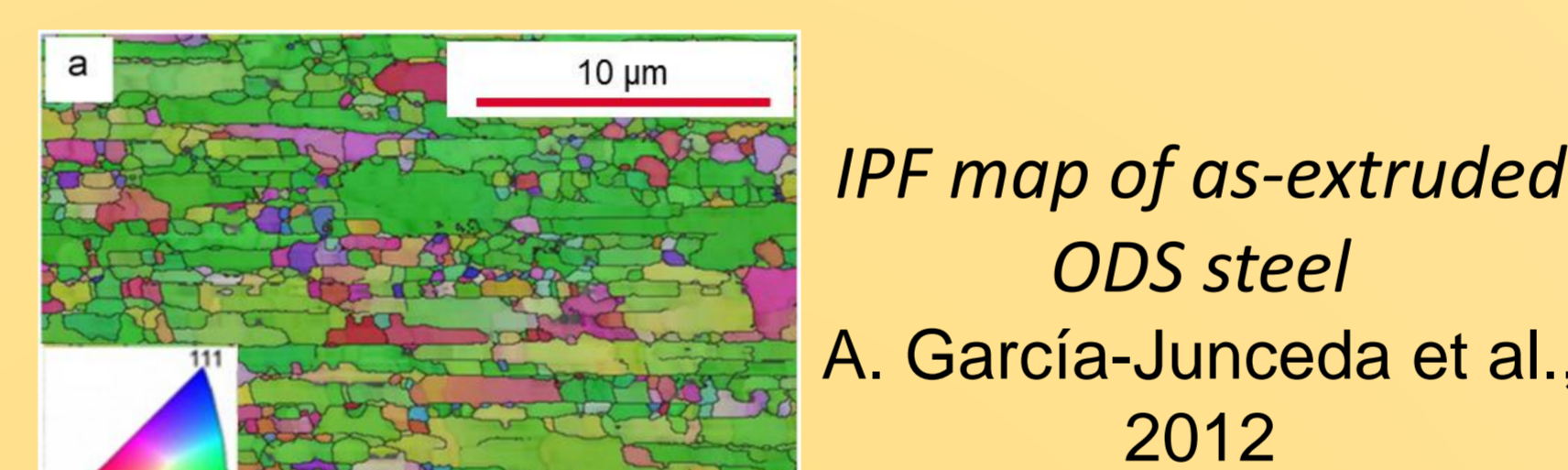
## Experimental Results

SEM images of cross-sections of SLM builds viewed in two different orientations



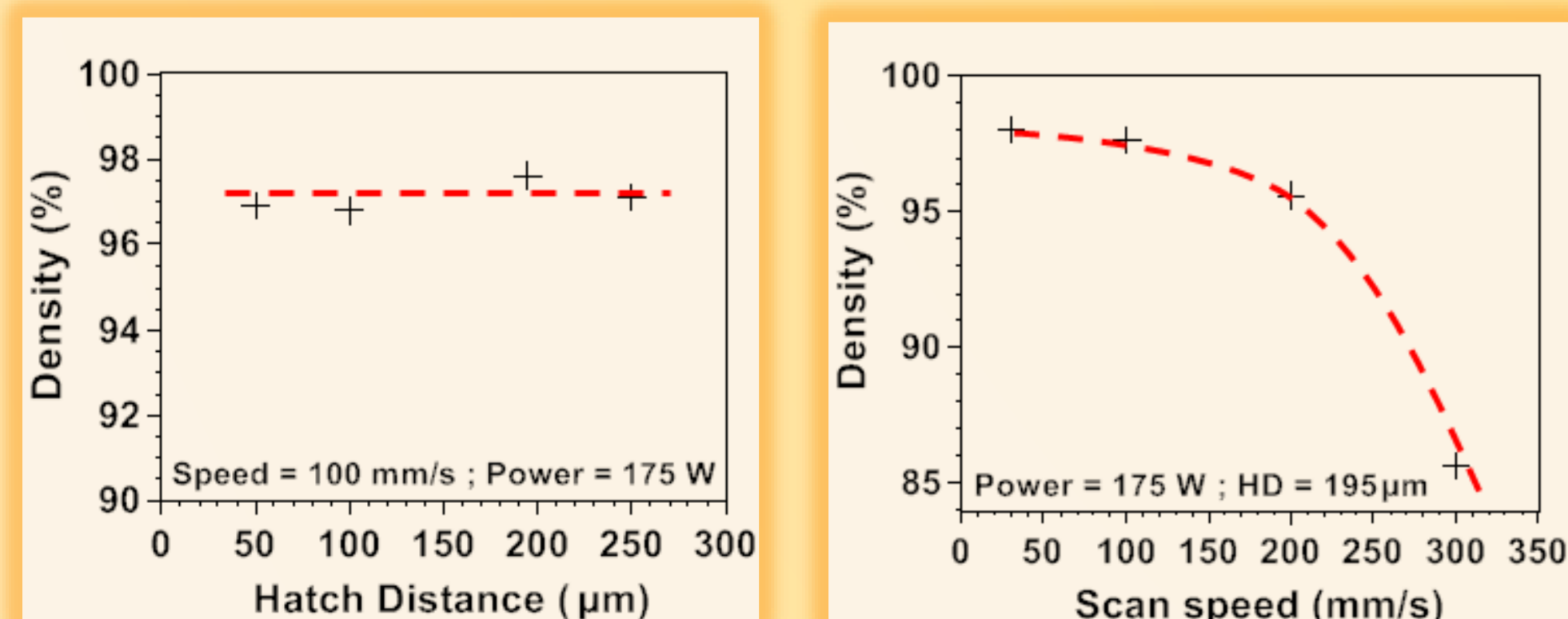
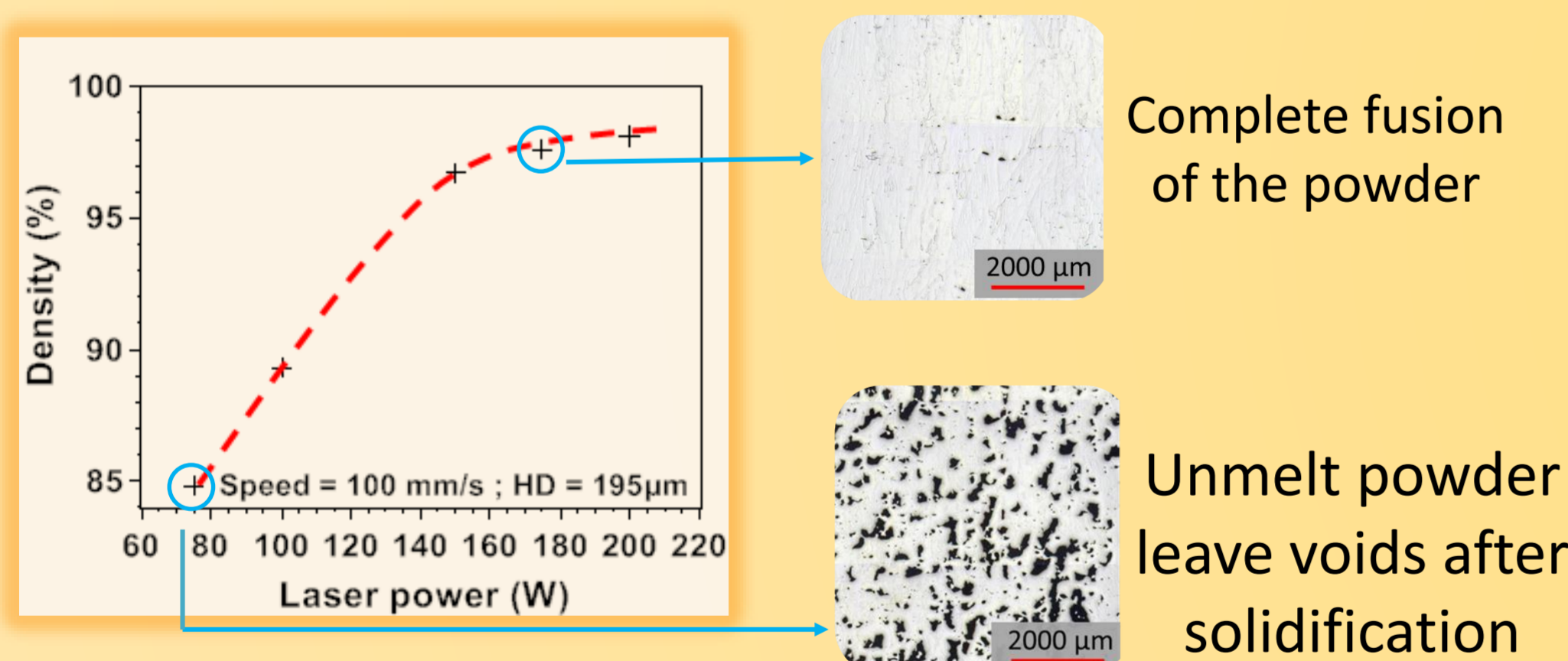
## Microstructure

- Columnar grains along the building direction (BD)
- Microstructure very different than microstructure coming from conventional route

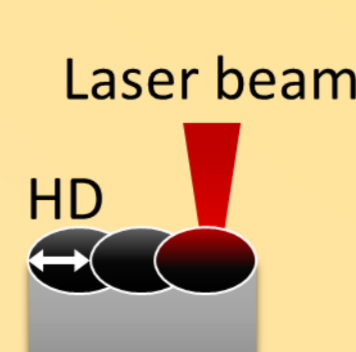


- Homogenous distribution of precipitates
- Precipitates rich in Y, Ti and O
- Mean diameter of precipitates : 30 nm

## Influence of process parameters on density

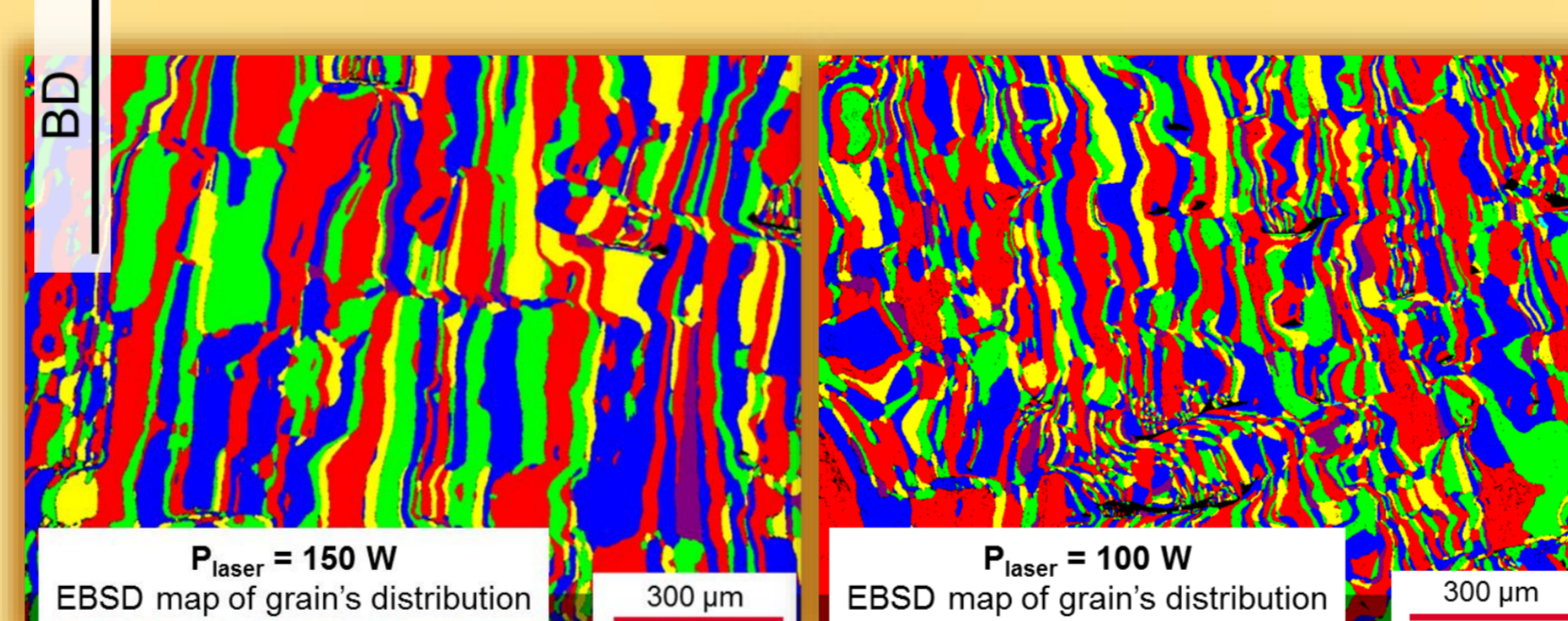


- To obtain a dense ODS steel :
- Power > 175 W
  - HD ~ track's width
  - Speed < 200 mm/s

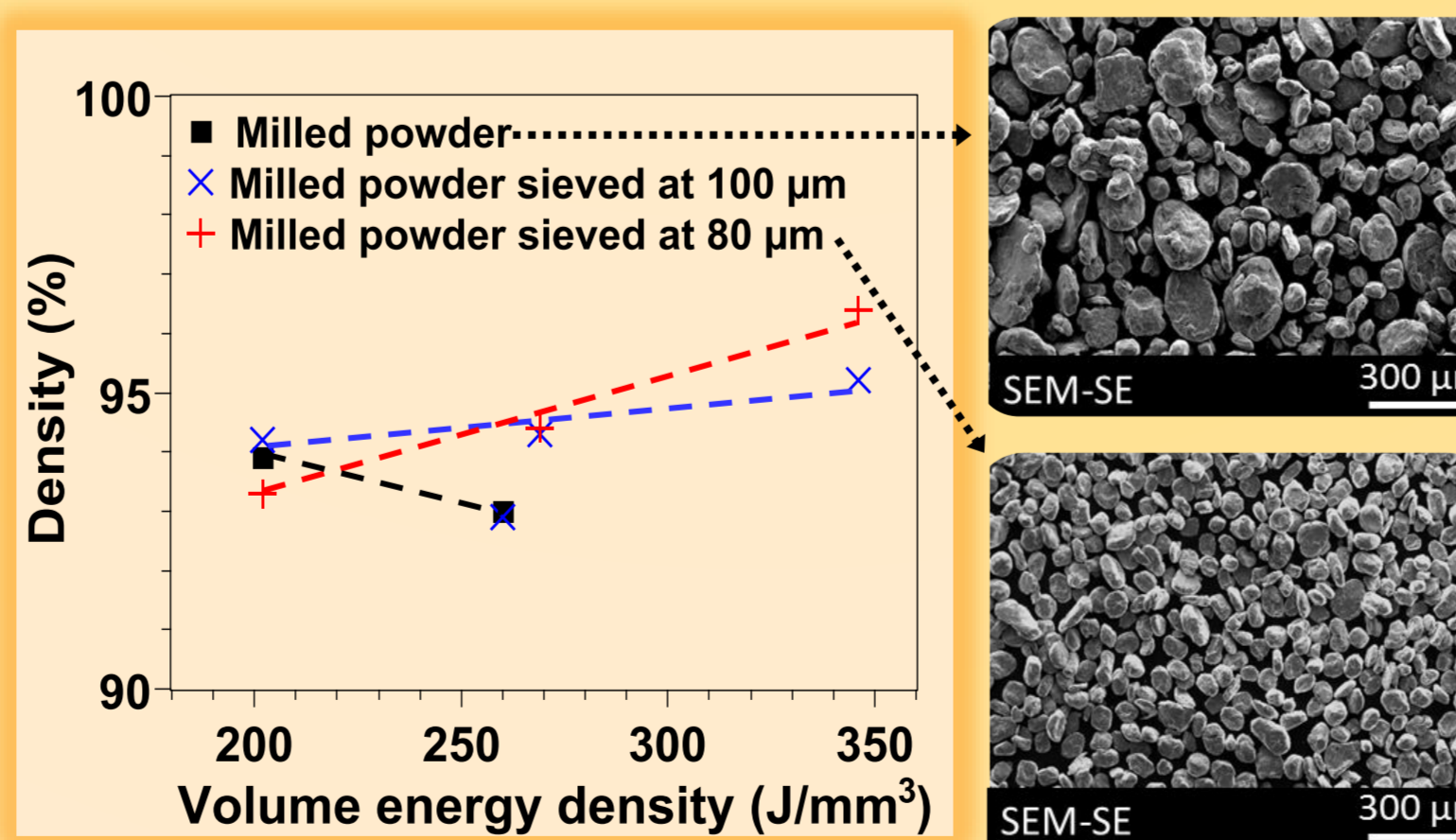


## Influence of process parameters on grain's size

Power	↘	Grain's size	↘
Speed	↘	Grain's size	↘
HD	↘	Grain's size	↘



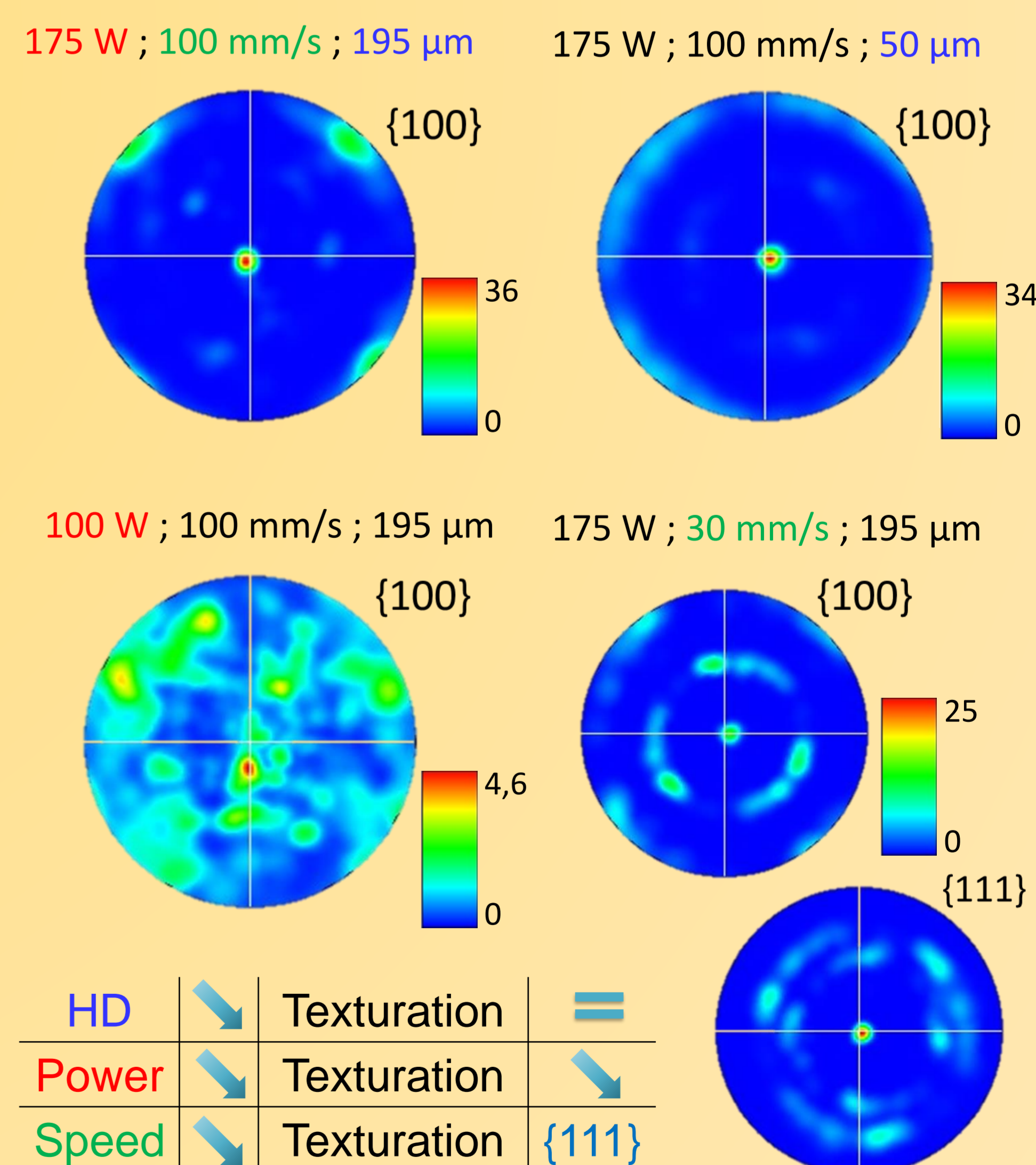
## Influence of powder size on density



$d_{50}$  powder ↘ Density ↗

## Influence of process parameters on texturation

- Strong fiber texture along building direction {100}



HD	↘	Texturation	↘
Power	↘	Texturation	↘
Speed	↘	Texturation	{111}

## Conclusion

- ODS stainless steel can successfully be produced by SLM process
- Innovative microstructure is obtained thanks to a good control of the process parameters
  - A good creep resistance is expected thanks to micrometric grains and homogenous distribution of fine precipitates

## Perspectives

- Study the influence of process parameters on precipitation
- Perform mechanical test : tensile tests, Charpy impact tests and creep tests
- Study the influence of process parameters on mechanical properties