METALLIC POWDER MANUFACTURE FOR CONDITIONING CAST IRON AS AN AM SUBSTRATE

O. Barrenetxea[1], R. González-Martínez[1], S. Wielowieyski [2], G. Artola[1], A.I. Fernández-Calvo[1]

[1] AZTERLAN, Basque Research and Technology Alliance (BRTA), Aliendalde Auzunea 6, 48200, Durango, Spain
E-mail: obarrenetxea@azterlan.es; rgonzalez@azterlan.es; gartola@azterlan.es; afernandez@azterlan.es

[2] 3D Lab Sp. z o. o., Farbiarska 63B, 02-862 Warszawa, Poland
E-mail: stanislaw.wielowieyski@3d-lab.pl

ABSTRACT

The main purpose of this work is to design and develop a metallic powder to use it as a paint for cast iron moulds allowing subsequent L-DED deposition on the parts to increase corrosion resistance and/or wear resistance. Cast iron is widely used in the manufacturing of several components with complex geometry and cavities due to its good castability, low cost and excellent machinability. Currently, different technologies of surface modification are used to increase the wear and/or corrosion resistance, but there are still many problems such as limitation on coating thickness, high cost and complex equipment [1]. L-DED (Laser Direct Energy Deposition) has been proposed as a potential solution without substantially increasing the price. However, L-DED on cast iron components is a difficult and a complex process due to the risk of heterogeneous thermal and stress fields formation as result of the graphite and matrix properties, formation of pores for carbon dioxide produced during the laser beam radiation and the formation of hard and brittle phases due to the high cooling rate that may lead to crack formation [2].

An intermediate coating with Ni-rich powder is proposed. For that, a Ni-3Ti wire of Ø 1 mm has been atomized in the ATO Lab+ metal powder atomizer in Azterlan using the 35 kHz ultrasonic module and the following process parameters: argon flow 20 l/min, 70 % power pump, 100 A arc intensity and 80 % ultrasonic amplitude. Table 1 compares the chemical composition of both Ni-3Ti wire and powder. Apart from minor variations, the most important change was the fading of Mn (~38 %).

Table 1. Chemical composition of Ni-3Ti wire and ultrasonic powder (wt. %)

Ref.	Ni	Ti	C	S	O	N	Si	Mn	P	Cu	Al	Fe
Ni-Ti wire	96.1	3.02	0.017	<0.005	0.003	<0.002	0.38	0.42	<0.01	<0.08	0.05	<0.1
Ultrasonic Powder	96.1	3.13	<0.010	<0.005	0.054	0.004	0.41	0.26	<0.01	<0.08	0.05	<0.1

As it can be seen in Figure 1, the produced powder has an excellent sphericity with no satellites. Some dark spots are observed in some particles, identified as titanium by EDX analysis in a Scanning Electron Microscope (SEM).

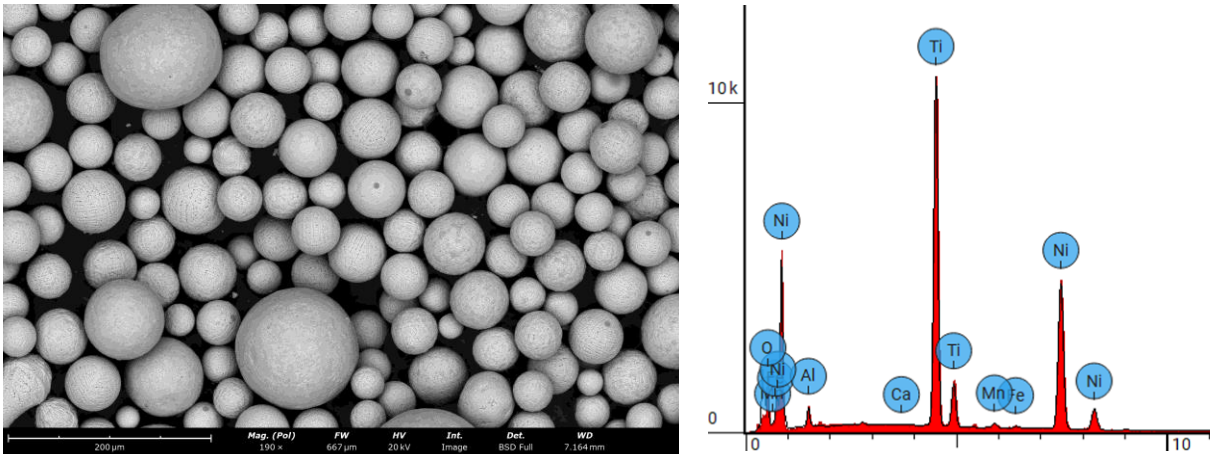
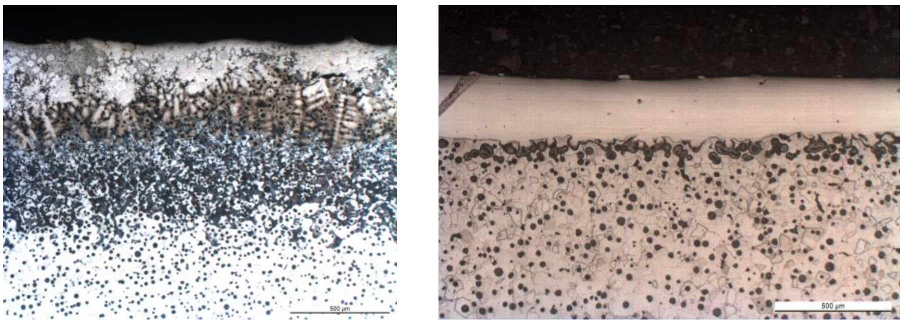


Figure 1. SEM image of the obtained powder and EDX of the dark spots.

The Ni-3Ti powder was mixed with a binder that was applied as a coat in the bottom part of a sand mold. Then, they were kept for 24 hours at room temperature to eliminate the moisture and get a solid coating. High silicon cast iron was melted in a medium-frequency furnace with a casting temperature ~1510-1520°C and poured into the sand mold avoiding direct pouring onto the coating. After demoulding, the surface was shoot blasted and L-DED single layer coat with Inconel 625 powder was deposited by MESHIND, using a L-DED Trumpf TruLaserCell 3000 machine. Figure 2a shows the microstructure of high Si cast iron coated with Ni-3Ti powder. There is a transition coating between cast iron and Ni coating. Figure 2b shows the microstructure after L-DED deposition. Note that no carbides are observed. Thus, it is possible to apply a hard coating over cast iron by introducing an intermediate diffusion layer of a powder base Ni-3Ti alloy.



a) b)

Figure 2. a) Resulting microstructure of the reaction of cast iron with the Ni coating; and b) resulting microstructure after L-DED deposition over the Ni coating.

KEY WORDS: L-DED, High Silicon cast iron, Surface modification, In-situ casting

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