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Effects of Precious Metal Doping on Stainless Steels Produced by Spark Plasma Sintering

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Introduction

- Stainless steels (SS) demonstrate poor corrosion resistance in reducing acidic environments
- Literature shows that the corrosion resistance of SS can be improved by coating and bulk alloying with precious metals. Due to high costs, these methods are not commercially viable
- This project aims to produce functionally graded (FG) 316L and 17-4PH SS doped with Pd and Ru by spark plasma sintering (SPS), reducing the amount of precious metals used and reducing costs
- The microstructure and corrosion and mechanical performance of the FG material will then be investigated

Spark Plasma Sintering Process

- SPS is a powder processing method
- SS powders were loaded into a graphite die and placed in a vacuum chamber
- A uniaxial pressure and pulsed DC were applied to the powder. By the Joule effect the powder was heated and held at the sintering temperature
- As the most influential parameter, sintering temperature was varied to optimise sample porosity, density and hardness

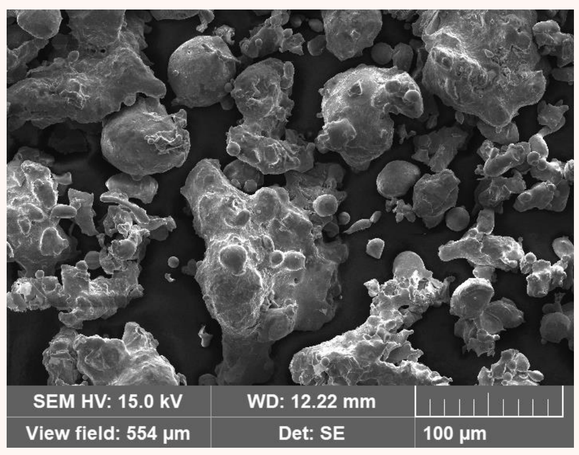

Figure 1. 316L with Pd powder

Table 1. SPS parameters

Sintering Temperature (°C)	1000-1100
Sintering Rate (°C/minute)	100
Holding Time (s)	600
Applied Load (kN)	16

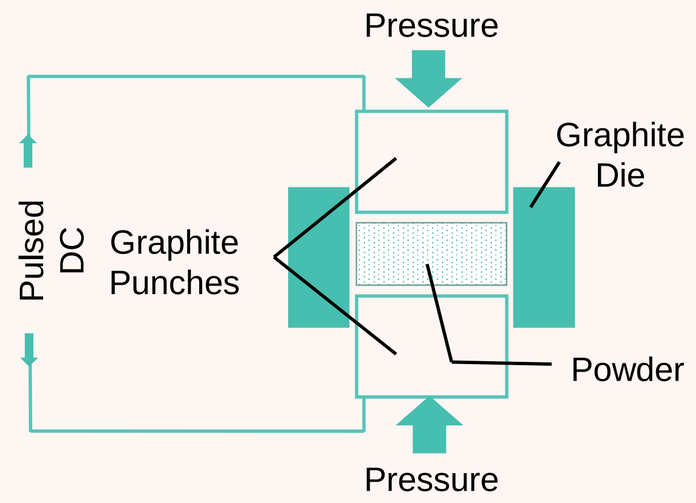

Figure 2. SPS diagram

Sample Hardness and Density

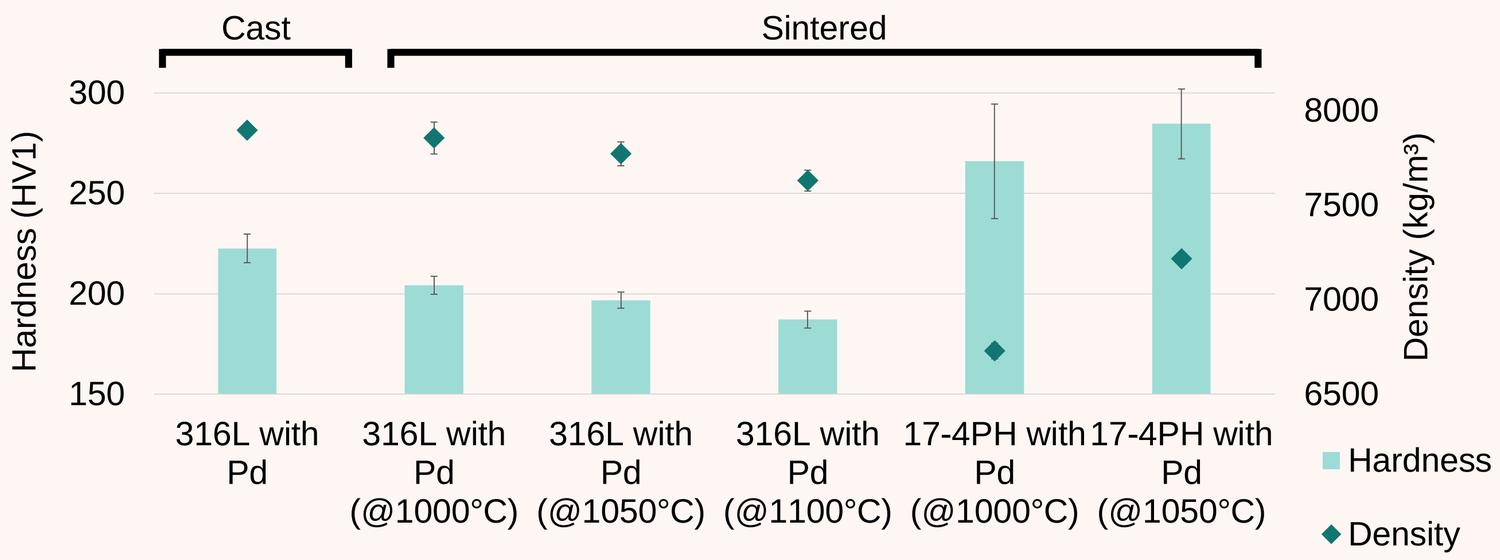

Figure 3. Graph of cast and sintered sample hardness and density

Porosity

- Preliminary pore analysis was achieved on optical micrographs using ImageJ

Table 2. Mean pore size at different sintering temperatures

Sample	Sintering Temperature (°C)	Mean Pore Size (µm²)
316L with Pd	1000	3.127 ±0.364
	1050	3.960 ±0.589
	1100	2.823 ±0.570
17-4PH with Pd	1000	9.025 ±2.174
	1050	6.460 ±3.637

Summary and Future Work

- Increasing sintering temperature improves hardness and density of 17-4PH samples but the opposite is true for 316L samples. Analysis of grain size will be used to assess whether grain growth is responsible for this trend
- Mean pore size decreases with sintering temperature for 17-4PH samples while it increases then decreases for 316L samples. The large error of these results means they are inconclusive, hence porosity will be further investigated by mercury porosimetry
- After suitable sintering parameters have been identified, FG samples will be fabricated
- Microstructural characterisation using scanning electron microscopy will be carried out followed by corrosion testing to analyse the effects of precious metal doping