

Effects of Sintering Temperature on the Properties of Stainless Steel Foam

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Abstract

Foam replication method is capable of producing foams with a highly porous structure with adjustable pore dimension, shape and size. In this work, this method has been used to prepare stainless steel 316L (SS316L) foam and sintered at 1200°C, 1250°C and 1300°C in a vacuum furnace. The microstructure and elemental analysis of the sample was examined using scanning electron microscope (SEM) and Energy Dispersive X-Ray (EDX). It was found that the average pore size was in the range of 330µm-350µm. The yield strength and elastic modulus are in the range of 58-66 GPa and 0.46-0.50GPa respectively. The samples shrinkage and yield strength increased as the sintering temperature increased.

Keywords: Stainless Steel Foam

Introduction

Metal foams are very attractive materials due to its properties which can be tailored and matched for a wide range of applications. The network-like metal foams exhibit a natural bone-like structure which allows the ingrowth of bone cells and blood vessels. The stiffness and strength of the metal foam can be tailored very close to the bone by changing the porosity [1]. According to G.S. Upadhyaya, sintering at high temperature will improve the mechanical and corrosion resistance of stainless steel foam [2].

Experimental Method

The SS316L slurry was prepared with the composition of 60 wt% SS316L, 5 wt% of binder and 35 wt% of distilled water by using a mechanical stirrer. Polyurethane foam was immersed in the slurry, and then manually retrieved from the suspension. After that, the excess slurry was squeezed out. The samples were dried at ambient temperature for 24 hours before sintered at 1200°C, 1250°C and 1300°C. The samples were then characterized by using SEM and EDX. The mechanical strength was determined by using compression test.

Results & Discussion

Fig. 1 shows the shrinkage percentage increased as the sintering temperature increased. All the samples experienced a volume shrinkage mainly due to the removal of the binder and PU foam template during the sintering process [3].

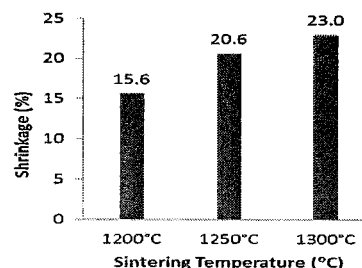


Figure 1: The shrinkage percentage of stainless steel foam sintered at 1200°C, 1250°C and 1300°C.

A further increase of sintering temperature will cause the closure of open pores and the shrinkage percentage increased [4].

Fig. 2 shows the pore morphology of stainless steel 316L foam sintered at different sintering temperatures. It can be seen obviously that the sintering temperature influence the microstructure of the samples. All the samples have interconnected pores with the average pore size in the range of 330 μ m-350 μ m.

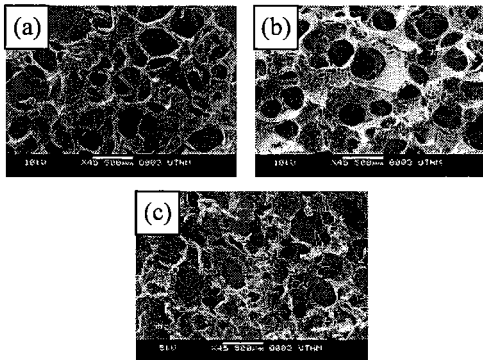


Figure 2: SEM images of porous stainless steel 316L sintered at (a) 1200°C, (b) 1250°C, and (c) 1300°C

From the EDX analysis, the contaminate elements were increased as the sintering temperature increase. The contaminate elements are included of O, Al, Ca, F, Sc and Rh. According to S.W.Kim et al., the amount of contamination can be reduced but cannot be completely eliminated [5]. These contaminate elements were picked up during the burnt-out of polymeric binder and sintering process [6].

Fig. 3 shows the yield strength and elastic modulus of the stainless steel foam sintered at different temperatures. The yield strength of the samples increased with the increasing of the sintering temperature. The elastic modulus decreased as the sintering temperature increased from 1200°C to

1250°C. There is no significant effect of the sintering temperature to elastic modulus of stainless steel foam which is in the range of 0.46-0.50GPa.

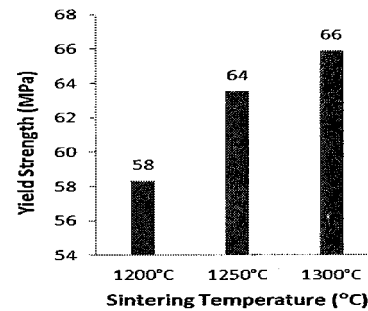


Figure 3: Yield strength of stainless steel foam sintered at different temperature.

Conclusion

The samples shrinkage and yield strength increased as the sintering temperature increased. Pore size was found in the range of 330 μ m-350 μ m, while the yield strength and elastic modulus are in the range of 58-66 GPa and 0.46-0.50GPa respectively.

References

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