Morphological Analysis of SS316L Foam Produced by using Slurry Method

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Abstract
Metal foams had been developed years ago by researchers. There were various methods used to produce metal foam such as slurry, compaction, gas entrapment technique and casting methods. In this study, slurry method used to produce SS316L foam with powder compositions 50wt%, 55wt% and 60wt%. Polyethylene Glycol (PEG) and Carboxyl Methyl Cellulose (CMC) were used as binder which was mixed with SS316L powder and distilled water. Polyurethane (PU) foams were impregnated with slurry and squeezed as ensure uniform coverage of every pore and struts of the PU foams. The coated PU foams were then dried in the oven for 24 hours at 30°C, followed by sintering process in the vacuum furnace at three different temperatures of 1200°C, 1250°C and 1300°C. Elements of Oxygen, Aluminium, Calcium, Silicon, Chromium, Nickel, Ferrous and Molybdenum were identified in the SS316L foams, as analysed by SEM-EDX analyses.
Keywords: metal foam, slurry method, SEM, EDX.

Introduction
Metal foams had many excellent physical and mechanical characterisations such as high porosity, high impact energy, corrosion resistance, low density and high stiffness [1,2]. Various types of metal foam include open cell, close cell and combination of both open and close cell metal foam. Open cell metal foam had interconnected struts which allowed fluid and gas to pass through [3]. Meanwhile, close cell foams sealed the pores and shares the walls [3].

Experimental Method
SS316L powder mixed with PEG, CMC and distilled water to form slurry. Next, the PU foams were impregnated in the slurry for 15 minutes. The excess slurry was squeezed out to ensure every pore and strut of PU foam were coated. Then, the PU foams were dried in an oven for 24 hours at 30°C to eliminate undesirable liquid [4]. Afterwards, the PU foams were sintered in the vacuum furnace at desired temperature. The SS316L foams physical characterisations were analysed by using SEM and EDX analysis machine.

Results and Discussion
Fig. 1 shows series of SEM result for 50 wt%, 55 wt% and 60 wt% SS316L foams sintered at 1200°C. Based on Fig.1, the number of open pores increased with increasing value of powder composition. Meanwhile, Fig. 2 shows the series of morphological result for 50 wt%, 55 wt% and 60 wt% sintered at 1250°C which were showed the pore and struts of SS316L foams. The strut size of SS316L foams decrease with increasing value of SS316L powder composition, as observed from Fig. 2. Thus this implies that the pore sizes were increased with increasing value of powder composition.

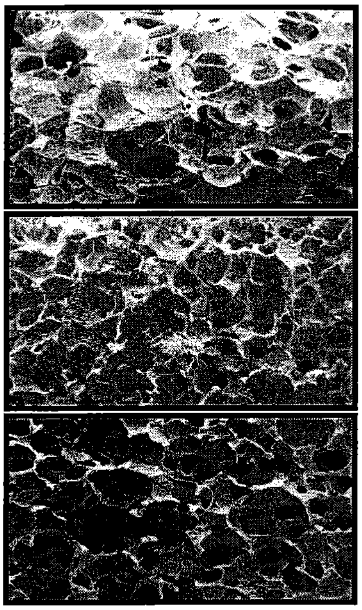

Fig. 1: SEM result for 50, 55 and 60wt% SS316L foams sintered at 1200°C

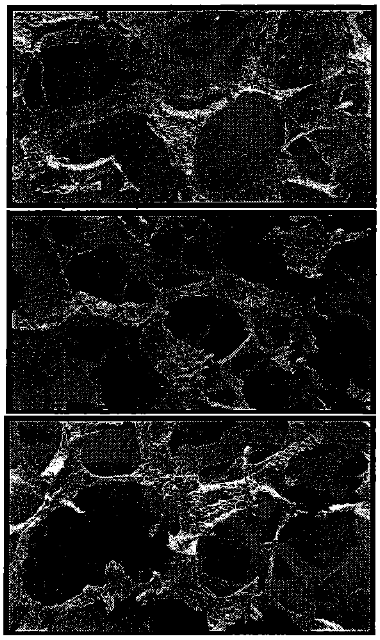

Fig. 2: SEM result for 50, 55 and 60wt% SS316L foams sintered at 1250°C

EDX analysis also been carried out for all samples which had 50, 55 and 60wt% SS316L powder composition which proved the existence of Oxygen, Aluminium, Calcium, Silicon, Chromium, Nickel, Ferrous and Molybdenum elements in the SS316L foams. Meanwhile, the elements of the SS316L powder were identified as Aluminium, Natrium, Phosphorous, Sulphur, Calcium, Chromium, Ferrous and Nickel. Nevertheless, the presence of Chromium element in the SS316L foam decreased as the sintering temperature increased. It is noted that Chromium assist in preventing corrosion happen to the SS316L foam [5].

Conclusion and Recommendation

SS316L foams were successfully produced by using slurring method with three different powder compositions and sintering temperatures. As to improve physical and mechanical properties of SS316L foams, some adjustments may be applied such as increasing the value of powder compositions and sintering temperatures.

References

[1] I. Mutlu and E. Oktay. Production and characterisation of Cr-Si-Ni-Mo steel foams: Indian Journal of Engineering and Materials Sciences. Vol. 18 (2011), p. 227-232

[2] L.I. Chang et al. Debinding of stainless steel foam precursor with 3-D open-cell network structure. Elsevier: Trans. Nonferrous Met. Soc. China. Vol. 20 (2010), p. 2340-2344

[3] A.K.S. Dawood and S.S.M. Nazirudeen. Jordan Journal of Mechanical and Industrial Engineering: A Development of Technology for Making Porous Metal Foams Castings. Vol. 4 (2010), p. 292-299

[4] S. Ahmad, N. Muhamad, A. Muchtar, J. Sahari, K.R. Jamaludin, M.H.I. Ibrahim, N.H. Mohamad and Murtadhahadi. Characterisation of Titanium foams sintered at different temperatures prepared by slurry method. Sains Malaysiana, vol.39 (1) (2010), p. 77-82.

[5] G.S. Upadhyaya, Sintered Metallic and Ceramic Materials, preparation, properties and application, first ed., John Wiley & Sons Ltd, West Sussex, England, 2000.