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Processing of electrolytic Cu metal foams by molten metal infiltration technique

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Abstract – Electrolytic copper foam has been processed by molten metal infiltration of a bed of amorphous silicon dioxide particles (silica-gel) removed by an aqueous HF acid as solvent. This technique has been recently proposed for processing a set of metals and alloys. Through this technique, a pure copper (melting point: 1084°C) foam having relative density ≈ 0.30 with highly homogeneous cell structure morphology was obtained. Because of the high chemical stability of space holder there was no chemical interaction with the metal has been found. On the other hand evidence of minimum metal corrosion shows the applicability of this technique for pure copper foaming.

Nature uses many cellular materials such as balsa wood, coral, and bones for structural and/or functional applications [1]. Different techniques are being developed for cellular metals processing [1-3]. One of the well-known techniques is molten metal infiltration of a leachable bed of solid particles, which will be removed by an appropriate solvent [1,3]. Traditionally, these particles (the space holder) are mineral salts with relatively low melting points, which are limiting the use of this technique for low melting point metals and alloys [3]. Recently, the use of amorphous SiO_2 particles as space holder and wet solution of hydrofluoric acid (HF) as solvent for metal foams production has been proposed [4,5]. The methodology is based on low cost consumables and simple technology leading to open-celled foams with interesting benefit ratios. Through this technique it is possible to foam HF resistant metals and alloys having melting points upto 1100 °C. The objective of this work is to present the results of pure electrolytic copper foam processing.

The material was processed in an induction furnace under argon gas at atmospheric pressure. A quantity of solid copper having almost 30% of the intended foam volume was placed at the bottom of a cylindrical crucible. A bed of pre-heated silica-gel beads was placed on the metal and the inductor was turned on. After complete metal melting plus approximately 100°C in overheating the inductor was turned off and the space holder was pressed down on the molten copper driving the infiltration through interstices. At this point the metal was able to solidify. The remaining solid (a sort of metal matrix composite, Fig. 1) was machined. Finally, the solid piece was submerged in an aqueous HF acid (25% vol.) till to complete SiO_2 dissolution. The result of this process is a open-cell copper foam having relative density ≈ 0.30 with highly homogeneous cell morphology (Fig. 2). Because of the high chemical stability of SiO_2 no chemical interaction with the metal has been detected, and evidences of metal corrosion were minimal that showing the applicability of the proposed technique for pure copper foaming.

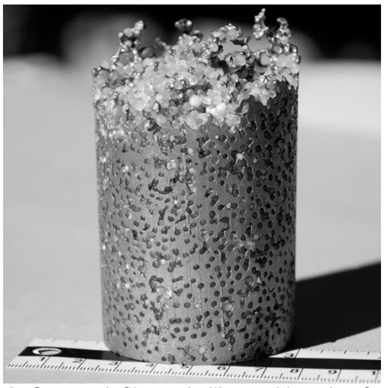

Figure 1: Copper infiltrated silica-gel beads after metal solidification.

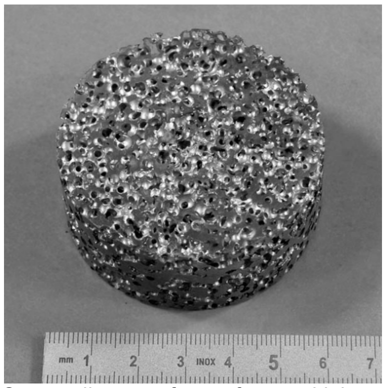

Figure 2: Open-cell copper foam after machining and space-holder dissolution.

[1] M.F. Ashby, A. Evans, N.A. Fleck, L. Gibson, J.W. Hutchinson, H. Wadley, Metal Foams: A Design Guide, Butterworth-Heinemann, 2000.
[2] J. Banhart, Progr. Mat. Sci. 46 (2001) 559.
[3] H.P. Degischer, B. Kriszt, Handbook of Cellular Metals: Production, Processing, Applications. Wiley-VCH, 2002.
[4] E.M. Castrodeza, C. Mapelli, PCT Patent Process MO2008A000166 (in progress).
[5] E.M. Castrodeza, C. Mapelli, J. Mat. Proc. Tech. 209 (2009) 4958.