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Macro and Nano Porous Materials

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Abstract

Porous metallic materials such as foamed metals, sponge-like metals, structural cellular metals, metals with directional pores and sintered metals are increasingly looked upon as potential light-weight structural and functional materials with, for example, superior sound absorption, damping and filtering properties. Not only porous metals but also porous ceramics, semiconducting materials and polymers are attracted much attention as unique functional materials in various fields, and some of them have been already implemented.

Keywords

Porous metallic materials; Foamed metals; Sponge-like metals

Recently new functional properties of bulk materials have been created by means of various techniques such as alloying, heat-treatment, plastic deformation and powder sintering. So far we have considered that the best way to produce high-performance functional materials is to decrease and/or eliminate any defects as much as possible. On the other hand, in a way different from conventional fabrication methods, porous materials effectively utilize pores and cavities by controlling their morphology in order to create new materials. Thus, porous materials initiatively aim not to densify the materials highly, but to densify lowly. In other words, new functional properties are derived by introducing many "null spaces" into materials intentionally.

The porous materials can be classified into two groups: macroporous and nanoporous materials. The former has the pores larger than micron meter in diameter, while the latter has the pores as small as nanometer. Besides, the materials also can be distinguished by the shape of pores, isotropic and anisotropic. Isotropic pores are spherical or polyhedral, while anisotropic pores are elongated pores aligned unidirectionally or distributed in random direction. Here, two kinds of examples on macroporous metals are shown in the next. Foamed metals can be fabricated by utilizing foaming phenomena; bubbling occurs when hydride is added into molten aluminum with high viscosity and during solidification process foaming takes place to produce foamed aluminum [1]. The porosity is more than 90%, which exhibits ultra-light-weight. Those are widely used to sound absorption materials and shock absorber for cars [2]. Another example is lotus-type metals with directional pores, which can be fabricated through unidirectional solidification by utilizing hydrogen solubility gap between solid and liquid. The specific strength in the direction parallel to the directional pores is equivalent to the strength of non-porous materials. Thus, lotus materials exhibit enough strength even in porous materials. Lotus copper and aluminum are expected to be used for heat sinks for electronics devices; the straight and penetrable pores look like a bundle of thin tubes. Coolant can flow through the pores under small pressure drop and effectively cool down the Joule-heated devices [3].

Recently nanoporous materials are attracted much attention. The nanoporous metals can be fabricated by dealloying method; from A_xB_{1-x} alloy either element is removed by chemical dissolution so that residual element forms porous body. Nanoporous metals are also fabricated by utilizing Kirkendall voids through interdiffusion. In medical technology DDS (Drug Delivery System) becomes powerful technique for cancer therapy. Nanoporous polymers are used for DDS. Anticancer drug is impregnated into nanopores to kill cancer. Single crystalline nanoporous metals exhibit super-strength because of ultra-low density of dislocations.

Thus, porous materials show peculiar characteristics, which are much different from the conventional non-porous materials. Although there are some progresses in research on porous materials, science and technology of porous materials have not been established yet; there are a lot of unsolved problems to be investigated. Many scientists and engineers are welcomed to engage in research and development of porous metallic materials, semiconducting materials, ceramics and polymers.

References

1. Ashby MF, Evans A, Flick NA, Gibson LJ, Hutchinson JW, et al. (2000) Metal foams: A design guide. Butterworth-Heinemann, Boston, USA.
2. Bibson LJ, Ashby MF (1997) Cellular solids. Cambridge University Press, London, UK.
3. Nakajima H (2013) Porous metals with directional pores. Springer, Tokyo, Japan.

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