Porous Aluminum for Heat Exchanger

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1 Abstract

To reduce global power demand, high performance of heat exchangers for inverters, IT devices and automotive devices (condensers, radiators) has been demanded. Hitachi Chemical has developed a new sintering method for aluminum powder, which was previously thought to be difficult to sinter. We have designed porous aluminum for a heat exchanger that takes advantage of its high specific surface area. In this paper, we describe features of the developed product, development history and technical contents.

2 Characteristics of Developed Products

- A high specific surface area (heat transfer area) can be achieved by a porous structure.
- Since aluminum is used as a base metal, the product is lightweight and has high thermal conductivity.
- The maximum porosity can be controlled up to 98%.

3 Development History

Porous metals have been expected as one of the most promising candidates for next-generation industrial material. Because of high porosity and high specific surface area, porous metals provide excellent functions such as shock absorption, damping, sound absorption, thermal insulation, and heat dissipation.

Particularly, a porous metal with open-cell structure is being considered for application to heat exchangers and electrode materials, because it allows fluid to flow easily and have large contact area with fluid. Focusing on its lightweight and high thermal conductivity, our company has developed a method for manufacturing porous aluminum with open-cell structure.

4 Technical Content

In general,aluminum powder has a stable oxide layer on the surface, making it difficult to sinter, even if performed in a reducing atmosphere. Therefore, we have developed new technology for sintering aluminum powder in a depressurized atmosphere. In this process (template method), we coated a resin form with aluminum powder and then the foam was thermally removed through the debinding process. Finally the debinded foam structure consisted of aluminum powder was sintered. By changing the specifications of the resin form and the conditions of the aluminum powder coating, we were able to control the porous structure such as the porosity and pore size. The appearance and the SEM image of the developed porous aluminum are shown in **Figure 1**, and the specifications of the porous aluminum are provided in **Table 1**. The developed porous aluminum has a complete open-cell structure with a pore size of 0.5 mm to 20 mm and a porosity of 93% to 98%.

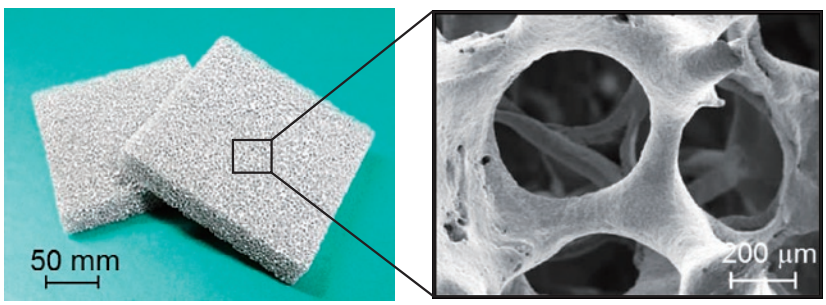
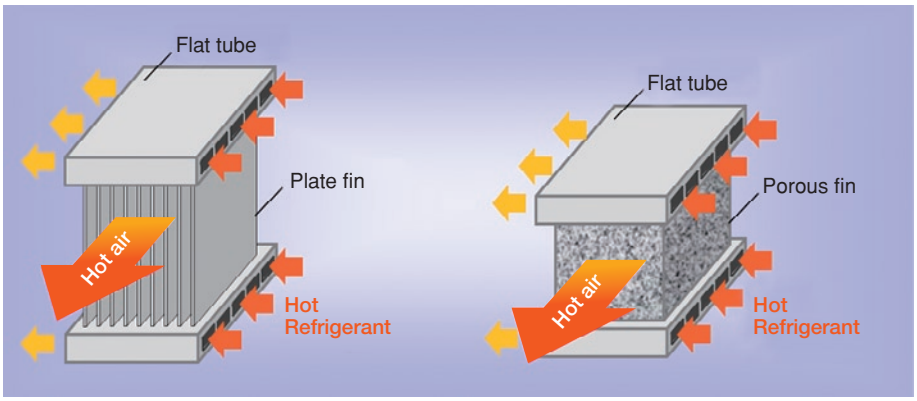


Figure 1 Appearance of porous aluminum and its micro-pore structure

Table 1 Characteristics of porous aluminum

Item	Unit	Characteristics
Porosity	%	93-98
Pore size	mm	0.5-2.0
Structure	—	Open Cell
Specific surface area	m^2/m^3	550～2,000
Compressive strength	MPa	0.15（porosity 97%）

Currently, to take advantage of the developed porous aluminum, we are working on applying this material to heat exchangers. **Figure 2** shows a comparison of the conventional fin (corrugated fin) and the porous fin. The porous aluminum has the following advantages: fluid easily flows through the open cells, and the contact area between the fluid and the porous aluminum is large. The application of the developed porous aluminum to a heat exchanger could increase the heat transfer area. This makes it possible to achieve higher performance and reduce the size of heat exchangers. Thus, the industrial value of the developed porous aluminum is high.



Conventional fin (Corrugated fin) Porous fin

Figure 2 Structural comparison of conventional fin and porous fin heat exchangers

5 Future Business Development

・Promote sales and extend the application of developed porous aluminum

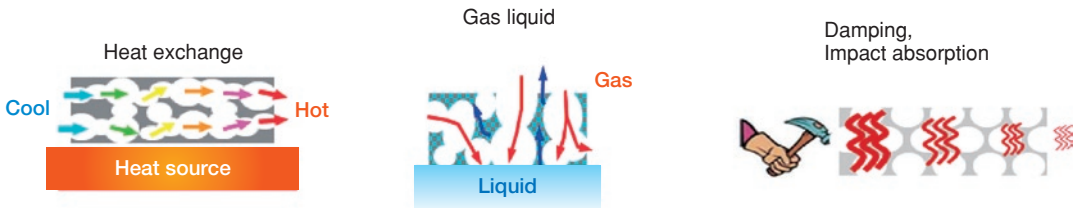


Figure 3 Applications

【Reference】

1) H. Koshita,“Development of highly porous aluminum with an open-cell structure”, PM2014 World Congress manuscript preprint, 2014, pp.496-504.