The Damping Performance of Porous Aluminum (PA) and Porous Aluminum-Polymer Composites (PAPCs) *

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Abstract

Porous aluminum (PA) and porous aluminum – polymer composites (PAPCs) were manufactured by means of special infiltration method, being composed of open pores in an Al matrix and polymer in an Al matrix respectively. It was found that both PAPCs and PA have high damping capacity and excellent damping characteristic. The damping of PAPCs is three times greater than that of PA.

The fabrication of PA, PAPCs by means of special infiltration methods, and their damping performance, which will be outlined in this paper, were seldom reported so far [1]-[3].

1.Experiment Method

1.1 The fabrication of PAPCs and PA

In order to fabricate PA and PAPCs, the "high pressure infiltrating" method has been proposed. A special preform which consists of particular polymer and other carrier, is put in a high pressure apparatus. Molten Al is infiltrated into the pores of preform under controlled high pressure. The special easy-burnt polymer and other carrier have no time to burn or deform during the infiltrating process because of the transient infiltrating time. When the molten Al solidifies, the PAPCs, which consists of polymer in an Al matrix, forms. After removing the carrier from PAPCs by burning it out, a PA with open interlocking pores is created. [1]

The other method to fabricate PAPCs is to infiltrate the molten polymer into PA with open pores.

1.2 The structure of PA and PAPCs.

The structure of PA consists of three–dimensional honeycombed Al matrix and open pores. The structure of PAPCs is similar to PA. The only difference is with granular polymer occupying open pores.

Usually, the diameter of pores in PA or polymer in PAPCs is 1.12~3.72mm. The porosity in PA and therefore the percentage of polymer in PAPCs is 73.5%~86.5%.

1.3 Test of damping performance

The measurement of damping performance was conducted using a viscoelastic meter IMASS. Three points bending with the sample size of 55mm×10mm×4mm was adopted. Frequency ranges from 1~10Hz, with amplitude of (1~5) $\times 10^{-4}$ was used. A comparison of measuring results between PA and PAPCs with same Al frame is given.

2.The Damping Performance

2.1 Damping characteristics of PAPCs and PA

Fig.1 (a) shows the dependence of damping Q^{-1} on the measuring frequency at fixed strain amplitude in PAPCs and PA. No obvious change was observed in either sample. The damping of PAPCs is three times greater than that of PA.

Fig.1 (b) shows the dependence of damping on the strain amplitude in PA under certain frequency (10Hz). The increase of Q^{-1} with the increase of measuring amplitude was observed when the strain amplitude is small. The Q^{-1} decreases with the increase of measuring amplitude when it is larger in both PA and PAPCs.

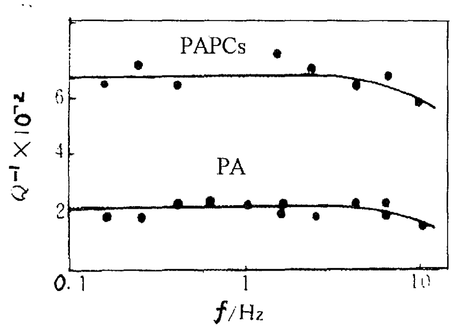

Fig 1(a) The influence of frequency on the Q^{-1} of PAPCs and PA ($A=2.5*10^{-4}$)

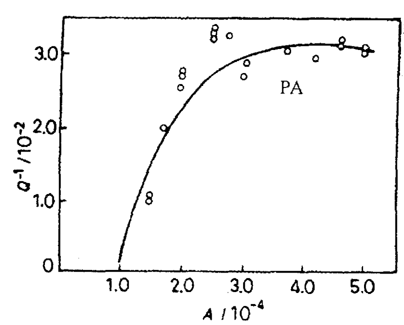

Fig 1(b) The influence of amplitude on the Q^{-1} of PA (f=10Hz)

2.2 The effect of pore structure on the damping Q^{-1} of PAPCs and PA

Fig.2 shows the effect of grain diameter of polymer on the damping performance of PAPCs. An obvious increase of Q^{-1} with the decrease of grain size (D) of polymer was observed in PAPCs. And the same results in PA was also observed.

Fig.3 shows the influence of polymer volume fraction of PAPCs on the damping performance while grain size (2mm) and measuring amplitude (2.5×10^{-4}) kept unchanged. The Q^{-1} rises with the increase of volume fraction of polymer. An obvious increase of Q^{-1} with the increase of porosity (P) was also observed in PA.

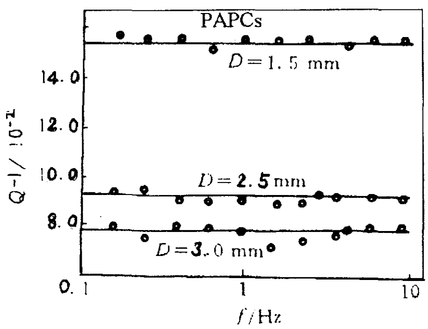

Fig 2 The influence of diameter of polymer on the Q^{-1} of PAPCs ($A=2.5*10^{-4}$, P=77.2%)

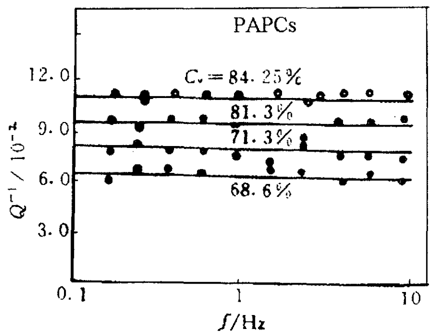

Fig 3 The influence of percentage of polymer on the Q^{-1} of PAPCs ($A=2.5*10^{-4}$, P=77.2%)

3.Discussion

The damping performance relates to the special structure of PA and PAPCs, which consists of pores, Al matrix and polymer, Al matrix respectively. When an external stress is applied, a big lag between stress and strain exists and therefore high damping appears.

Some factors such as volume fraction, size of pore or polymer grain, metal frame, different kinds of polymers, interface between polymer and metal frame, and so on are important for the damping performance.

After a detailed study on the relation between the damping performance and the specific surface area, it is concluded that the Q^{-1} increases with the increase of the specific surface area in PA and PAPCs as shown in Fig 4. So the Q^{-1} of PA and PAPCs can be modulated by changing the structure parameter. They are a class of high damping material which are easy to fabricate, of lower cost and higher damping than general high damping alloy and are suitable for use in various fields.

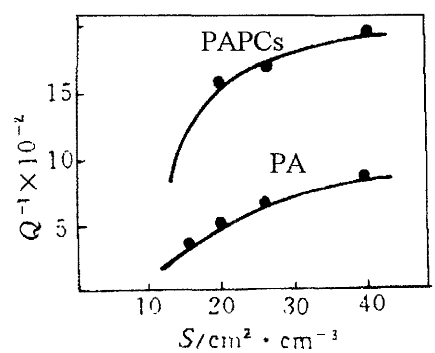

Fig 4 The influence of specific surface area on the Q^{-1} of PAPCs and PA

4.Conclusions

(1) The new type of PA and PAPCs made by a special infiltration method is composed of pore, Al matrix and polymer, Al matrix respectively.
(2) Both PAPCs and PA have higher damping and excellent damping characteristic: Q^{-1} is independent of the frequency, and is in relation with amplitude.
(3) The damping Q^{-1} increases with the increase of pore porosity, polymer volume friction, specific surface area and with the decrease of pore or polymer diameter.

Acknowledgment

The authors are thankful to the National Science Foundation of China for the financial support.

Reference

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