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Soft Aerogels Supported by ~1 mass% Carbon Nanotubes for Thermal Interface Materials

Thermal interface materials (TIMs) are used for enhancing heat transfer between solid surfaces by creating thermal paths. Their important characteristics are high thermal conductivity and softness for filling the air gaps. However, many conventional TIMs consist of the thermal conductive fillers dispersed in polymer matrix, which has disadvantages of low thermal conductivity and poor thermal stability. Here we propose aerogel TIM replacing polymer matrix with air matrix. Air matrix is released upon pressing and conductive fillers can directly contact each other. A soft sponge like self-supporting film can be fabricated using carbon nanotubes (CNTs), and this structure is able to support fillers 100 times larger in mass compared with their own mass [1]. Moreover, the CNTs do not disturb heat conduction between fillers because CNTs have high thermal conductivity, and the CNTs also have high thermal stability (500 °C in air). We selected silver having the highest thermal conductivity among the metals as conductive filler. The aerogel TIM was fabricated by hybridizing Ag particles with CNTs (Fig. 1a, b). The TIM was self-supporting even when the amount of fillers was 200 times as large as that of CNTs. From the result of steady-state thermal resistance measurement, the thermal resistance of 99.5 mass% Ag-0.5 mass% CNT-TIM between two Cu rods was 40 mm^2 K/W under 0.8 MPa (Fig. 1c). TIM showed lower thermal resistance with lower CNT content. In addition, selecting the surfactant for keeping Ag particle clean and dispersing CNTs well is one of the key factor to obtain lower thermal resistance. Optimization of the structure is now underway, and the latest results will be reported.

References

[1] K.Hasegawa and S. Noda, J. Power Sources 321, 155 (2016).

Figures

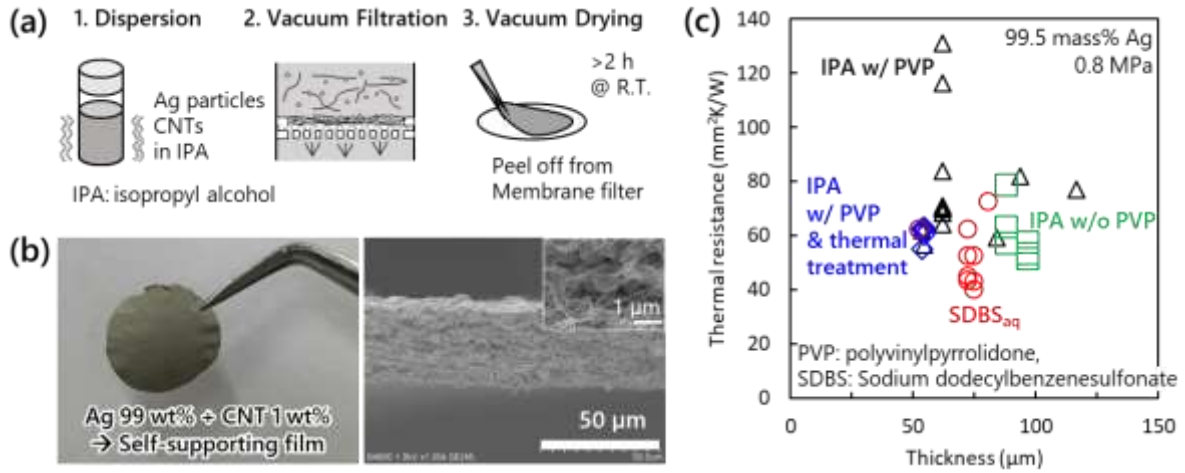

Figure 1: Fabrication process and thermal resistance of Ag-CNT aerogel TIMs. (a) Fabrication process. (b) Digital and SEM images. (c) Thermal resistance of the TIMs with different surfactants.