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Thermal interface materials made of vertically-aligned multi-walled carbon nanotubes

Carbon nanotubes (CNTs) are promising materials for next generation of electronics by virtue of their supreme physical properties such as tolerance for high current density and thermal conductivity on the same level with diamond [1, 2]. Actually, applications of CNTs to interconnects and thermal interface materials have been studied [3-4]. Unfortunately, there are many issues caused by difficulties in connecting CNTs to other materials like metal electrodes, where small electrical/thermal contact resistance is necessary. Here, we focus on the application of vertically-aligned CNTs to thermal interface materials (TIMs).
Vertically-aligned multi-walled CNTs were grown on a silicon substrate with a thermal silicon dioxide layer by chemical vapor deposition (CVD), as shown in figure 1(a). After peeling CNTs off the substrate, the CNTs were annealed at temperatures above 2000°C and pressed to form a CNT sheet, as shown in figure1b). The thermal property of CNT sheets was measured by a temperature gradient method. Figure 1(c) shows the dependence of the thermal resistance of CNT sheets (annealing temperature: 2400°C) including the interface resistance on the pressure applied at the time of the measurement. It was found that the thermal conductivity of CNT sheets was estimated to be approximately 80 W/mK. The results of Raman spectroscopy showed that the annealed CNTs are of high quality, supporting this high thermal conductivity of CNT-TIMs. Our results indicate that CNT sheets annealed above 2000 °C are really promising for future TIM applications.

References

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Figures

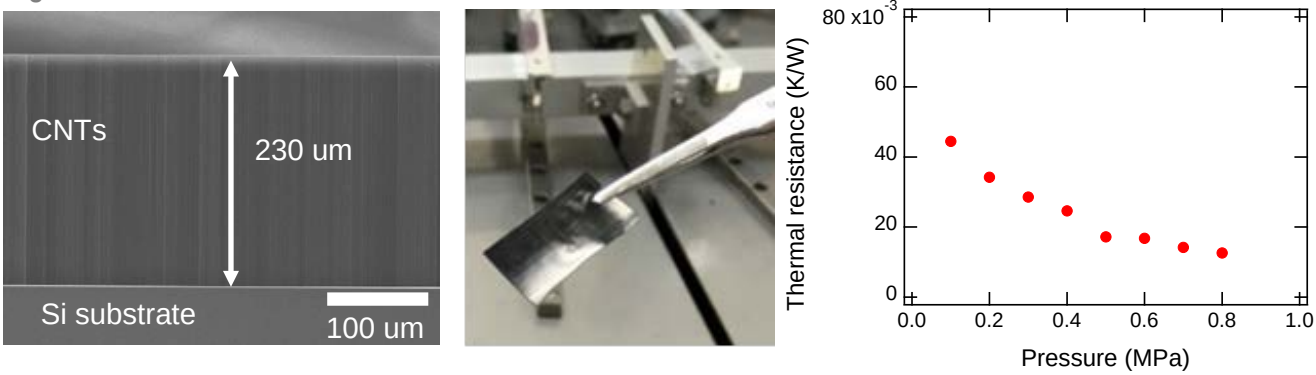

Figure 1(a): SEM image of CNT sheets after annealing at 2400 °C. (b): Photo image of CNT sheets. (c): Thermal conductivity of CNT sheets dependent on pressure.