

# Reusable Thermal Conductive Sheet Containing Vertically Oriented Graphite Fillers“TC-S01A”

*Michiaki Yajima*

Advanced Performance Materials Operational Headquarters,  
Advanced Core Materials Business Sector,  
Inorganic Materials R&D Department

*Motoaki Yui*

Advanced Performance Materials Operational Headquarters,  
Advanced Core Materials Business Sector,  
Photosensitive Materials R&D Department

*Toru Yoshikawa*

New Business Development Headquarters,  
Tsukuba Research Laboratory,  
Social Infrastructure-related Materials Development Center

## 1 Abstract

As the performance of semiconductor package improves and they become increasingly compact, the need to control heat through thermal interface materials has become more and more important. To meet the demands for thermally conductive and flexible material, we have developed and commercialized a high-performance solution. By orienting graphite fillers vertically within an acrylic rubber-based matrix, the TIM (Thermal Interface Material) we developed provides both high thermal conductivity and flexibility.

Generally, a TIM can be applied and used only once. However, we discovered that CPU testing and machine maintenance applications demand ease of reuse. In this report, we will discuss how we developed a metal foil laminated TIM which facilitates removal and reuse.

## 2 Key Features

- Aluminum foil is only applied to one side of the sheet, allowing for one sided reusability.
- Because this thermal conductive sheet uses vertically oriented graphite fillers, high thermal conductivity is achieved in the “Z” direction.

## 3 Development Background

We developed the TIM (Thermal Interface Material) TC-001, containing vertically oriented graphite fillers in an acrylic rubber-based matrix, by applying our composite and structural control technology to combine these two materials effectively. Figure 1 shows an image of a cross-section of TC-001, revealing the vertically oriented large-particle graphite creating a pathway to the other side in TC-001. This structure has achieved 90 W/m · K thermal conductivity in the thickness direction.

To apply TIM (Thermal Interface Material), it should be sandwiched between the heating element and heat sink to boost heat transfer efficiency. However, it should also be repeatedly used to improve productivity in Burn-In Tests as an initial characteristic confirmatory test for CPU'S. When it is necessary to exchange CPUs or power modules used in electronic devices, general purpose grease may cause Burn-In and exchanging such parts for repair can be extremely difficult.

In this context, we attempted development work to impart reusability while maintaining the high thermal conductivity of vertically oriented graphite based TIM.

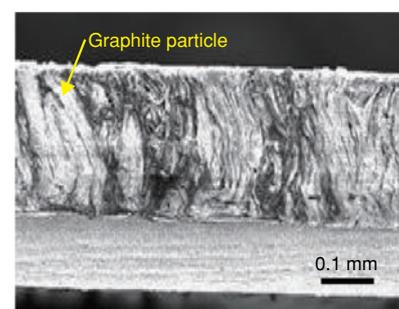


Figure 1 Cross-sectional image of TC-001

## 4 Technical Content

### (1) Design concept to impart reusability

Figures 2 and 3 show the cross-sectional structure and exterior appearance of TC-S01A, respectively. TC-S01A uses soft aluminum foil, which can prevent oxidation degradation by forming a passive state. In combination with TIM with vertically oriented graphite, TC-S01A realizes, ① high thermal conductivity (15 W/m·K, including contact resistance), ② No sticking to the heating element, and ③ Flexibility.

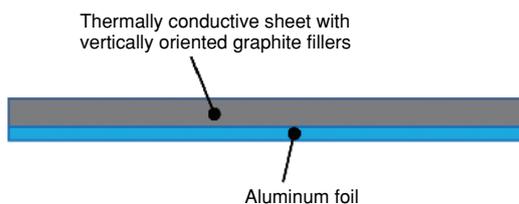


Figure 2 Structure of TC-S01A

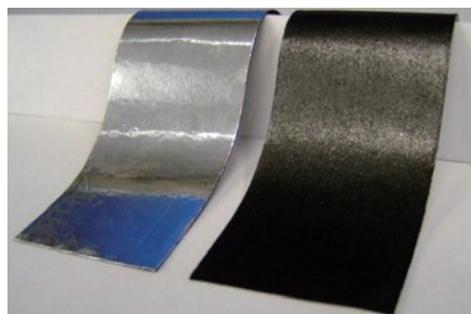


Figure 3 Appearance of TC-S01A (Left) Aluminum foil side (Right) Sheet side

### (2) Assessment of reusability

Figures 4 and 5 show the stress-strain curve and thermal resistance change after 1000 cycles of the TC-S01A compression recovery test. TC-S01A can show a reduction in curbed thickness and additionally retained recovery properties after repeated stress in the direction of vertically oriented graphite. It was also confirmed that thermal resistance levels did not worsen. TC-S01A excels in terms of reusability under harsh temperature conditions and is expected to become a main component in semiconductor applications including Burn-In Inspections and electronic devices such as power modules.

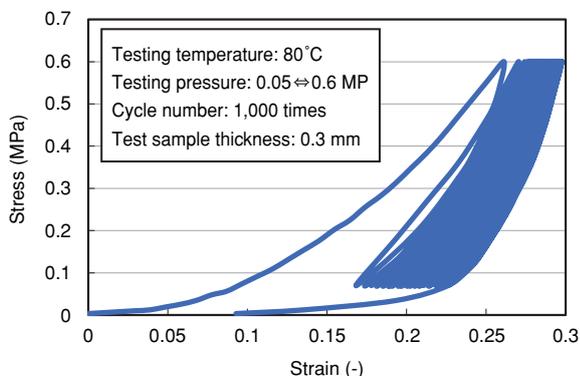


Figure 4 Stress-strain curve

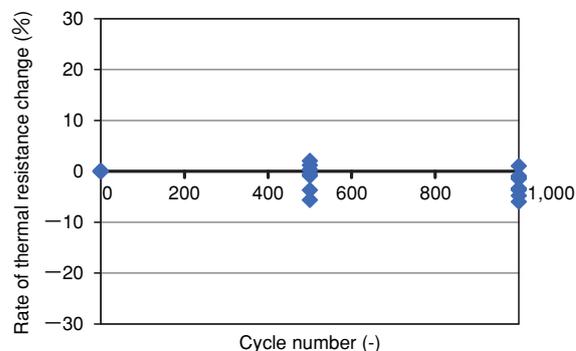


Figure 5 Change of thermal resistance with compression test

## 5 Future Business Development

- Development of TC-S01A for various applications at home and abroad

### 【Reference】

- 1) Hitachi Chemical Technical Report No. 53 (2009-10)