December 2023

Functionality and benefits of the CLS system: Rapid curing electrically conductive adhesive.

Keisuke Ota, Ryo Ogawa,

Introduction

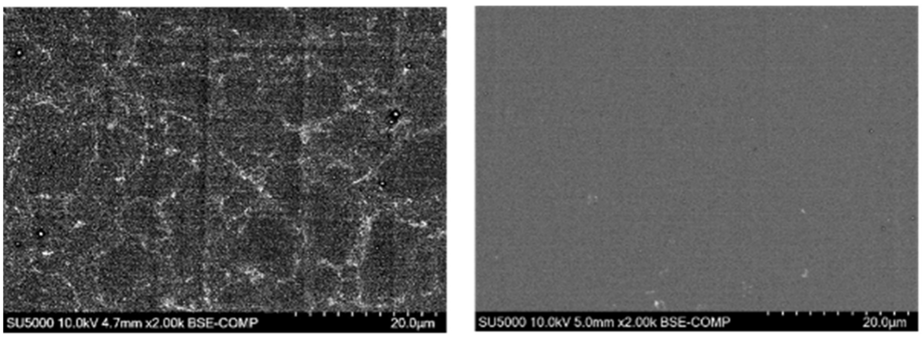
Conventionally, solder has been used as a conductive joining material for electronic components, etc., and in many cases Sn-Pb alloys have been used. However, there have been concerns about adverse effects on the human body and the environment due to the lead content, and there have also been issues such as the need for high temperatures for joining. Therefore, electrically conductive adhesives have been applied as an alternative to solder, which are formed by electrically conductive fillers in polymer materials. Electrically conductive adhesives have the advantages of low environmental impact, low-temperature joining and the ability to maintain adhesive strength even at high temperatures.

Many technologies have been proposed for compounding polymers with conductive fillers. For example, it has been proposed to blend conductive particles, such as metal particles, into adhesive compositions obtained by containing cyanate ester resins, epoxy resins and latent curing hardeners [1]. A core-shell type curing agent with an imidazole-modified structural component as the core is used in this reference, but it was not satisfactory in terms of conductivity and curing properties.

Now, ADEKA has proposed new possibilities such as ultra-fast curing adhesives by applying the CLS system, which is a new formulation technology using epoxy resins, latent curing agents for one component systems and highly reactive compounds such as cyanate ester resins. This paper reports the functionality of electrically conductive adhesive formulations based on the CLS system.

Application to conductive adhesives

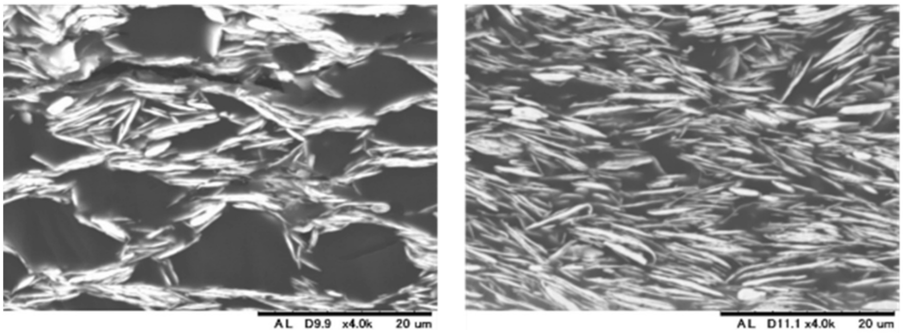
The CLS system enables phase-separated structures to be formed during curing while maintaining rapid curing properties by optimizing the formulation. Observing the cross section of the cured material, it can be confirmed that the CLS system cured system (1a) has a distribution in resin density and forms a phase-separated structure in the system compared to the general epoxy resin cured system (1b) (Figure 1).



1a: CLS system　　1b: Conventional system

図 1 SEM cross section of cured material.

Ag filler, which is widely used in conductive adhesive materials, was formulated into the above formulation, and cured. It gives a cured material with a three-dimensional mesh structure in which Ag filler is aggregated (Figure 2, 2a). In the system using the CLS system, conductivity was achieved with as little as 18.5 vol% Ag filler, indicating that the formation of a three-dimensional mesh structure by agglomeration is an efficient conductive path (Table 1).



2a: CLS system 2b: Conventional system

図 2 SEM cross section of cured material containing Ag filler.

Table 1 Volume Resistivity of Cured Material

sample	2a	2b
Ag filler (vol%)	18.5	18.5
Volume resistance (Ω cm)	8.0×10^{-3}	$> 10^{6}$

This formulation also has the fast-curing properties that are characteristic of the CLS system, and can provide high adhesive strength in a short time of only 10 seconds, which was not possible with conventional compositions. Furthermore, high final adhesive strength can be achieved due to lower Ag filler content, which provides the same electrical conductivity (Figure 4).

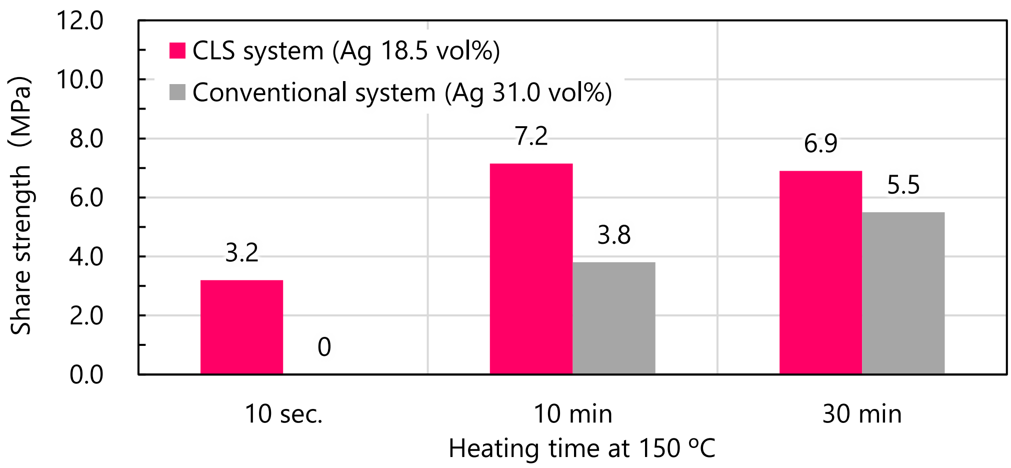


Figure 4 Adhesive strength on Cu

Currently, we are developing laser-curable conductive adhesives featuring ultra-fast curing and efficient conductive path formation, and have developed the lineup shown in Table 2. The development of high conductivity with a small amount of Ag filler is expected to reduce the weight of materials and improve adhesion.

Table 2 Typical Properties of Conductive Adhesives

	Standard grade ADEKA REMYLOP FL-387	High Heat-Resistant Grade ADEKA REMYLOP FL-388
Near-infrared laser curing	Possible	Possible
Viscosity / 25 °C Pa·s / 10rpm	23	27
Glass transition temperature (DMA) °C	140	170
Coefficient of linear expansion (<Tg) ppm	43	43
Volume resistivity Ωcm	2×10^{-3}	3×10^{-3}

Conclusion

As an example of application of the CLS system, which has a new and unconventional curing behavior, electrical conductivity has been successfully achieved using Ag filler. This electrically conductive formulation shows high electrical conductivity with a smaller amount of Ag filler by localising the Ag filler through the formation of a phase-separated structure during curing.

As the CLS system features ultra-fast curing, it can be successfully adapted to short-time curing processes, such as near-infrared laser heating systems [2-4], etc., which enables joining in a short time as with conventional solder.

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