Surface Modification of Ag Coated Cu Conductive Metal Powder for Conductive Silicone Sealant Gasket Paste

Seong-Yong Park[1, a], Tae-Won Yoon[2,b], Chung-Ho Lee[2,c], In-Bum Jeong[2,d] and Sang-Hoon Hyun[1,e]

[1] Department of ceramic engineering, Yonsei University, 134 Shinchon-dong, Seodaemun-gu, Seoul, Korea,
[2]R&D center, Changsung corporation, 11-9, Namdong Industrial area Namdong-Ku, Incheon, Korea
[a] yeonrigi@chansung.com, [b] thunder@changsung.com, [c] chlee@changsung.com,
[d] ibjeong@changsung.com, [e] prohsh@yonsei.ac.kr

Abstract

Conductive pastes consist of conductive fillers(Au, Ag, Ni, Cu etc.), organic binders, solvents and additives. Meanwhile, there are some metal powders such as copper, nickel etc that are used for pastes which have serious surface corrosion problems. This problem leads to change of the color and decrease in conductivity and affect storage stability of conductive pastes. By using silane coupling agent and dispersion agent, we can ensure both the corrosion stability and long term storage stability, and enhance the high performance electrical and mechanical properties of EMI shielding silicone sealant.

Keywords : EMI shielding gasket, Ag coated Cu, Dispersing agent, Silane coupling agent

1. Introduction

Electromagnetic interference (EMI) shielding refers to the reflection and adsorption of electromagnetic radiation by a material, which thereby acts as a shield against the penetration of the radiation through the shield. [1] However, with the increase in operating frequency and the integration of electronic devices, EMI has become a major problem as it reduces the lifetime and the efficiency of electronic devices and electrical products. [2] To reduce EMI problem in the cellular phone industry, various EMI shielding techniques have been adopted. [3, 4, 5]

In this paper, we focus on the form in place gasket (FIPG) for EMI shielding which is made up of dispersed micron size conductive metallic particles in RTV-silicone rubber. The necessary characteristics of conductive silicone sealants are good adhesion characteristics to the surface of EMI paints sprayed and sputtered metallic surface, uniform dispersion of metallic particles in silicone rubber and long time corrosion stability of copper and nickel derivative metallic particles. [6] Silane coupling agent and Dispersing agent can be used for these purposes. [7, 8]

2. Experimental and Results

Silanol terminated silicone polymer and crosslinker were obtained from Hanse Chemie, Germany. Silver coated copper made in changsung corporation, Korea. Dispersing agents were supplied by BYK (Germany), Kusumoto chemicals (Japan), and EFKA (Germany). Silane coupling agents were supplied by Shin-Etsu chemical (Japan), Dow corining (USA), and Chisso (Japan). The guideline for the silane coupling agent and dispersing agent are shown in *Tables 1 and 2*.

First, surface modified silver-coated copper powder was prepared by direct coating of silane coupling agent method. Second, silicone sealants were prepared using planetary mixer under 35℃. Finally, the physical properties of shape controlled and room temperature cured sealant was tested. Corrosion stability was also tested by constant temperature oven at 50℃ and for 24Hr (acceleration test).

Table 1. Silane coupling agent and its formula

Code name	Silancoupling agent	Organic group	Inorganic reactivity
SC#1	3-Aminopropyl triethoxysilane	Amino	Ethoxy
SC#2	Vinyltrimethoxysilane	Vinyl	Methoxy
SC#3	3-Glycidoxypropyl trimethoxysilane	Epoxy	Methoxy
SC#4	3-Methacryloxypropyl trimethoxysilane	Methacry late	Methoxy
SC#5	Methyltrimethoxysilane	Methyl	Methoxy
SC#6	n-Octyltriethoxisilane	n-Octyl	Ethoxy

Table 2. Dispersing agent and its main component

Code name	Main component	Acid value (mg KOH/g)
DP #1	Long chain Aliphatic polycarboxylic acid	-
DP #2	Modified polyester amine salt	58
DP #3	Alkyleneglycol phosphate ester surfactant	-
DP #4	High molecular weight carboxylic acid amide amine salt	32
DP #5	Modified polyurethane	17-21

The effects of silane coupling agent are shown in *Table 3*. As shown in *Table 3*, the silicone sealant that composed of silane coupling agent coated silver/copper powder has a higher corrosion stability compared to the none treated sealant. Especially, SC#1 and SC#6 showed excellent resisitivity change ratio of 30% and 52% increase compared to the primary state. It seems that the ethoxy group, which exists as inorganic reactivity of silane coupling agent, interact well with the metal surface rather than the methoxy group. The reason of this phenomenon is that molecular level coating of silane coupling agent onto the surface of silver/copper powders improve the corrosion resistance of copper.

Table 3. The volume resistivity and change ratio after acceleration test of silicone sealant adopted direct surface modification method of silane coupling agent

Silane coupling agent	Volume resistivity (V.R.)	V.R. change ratio
Unit	($x10^{-3}$) Ω-cm	%
None	0.72	+520
#1	0.70	+30
#2	0.68	+462
#3	0.61	+223
#4	0.91	+140
#5	0.70	+154
#6	0.82	+52

Table 4 shows the effects of dispersing agent to EMI silicone sealant and *Figure 1* also shows the effects of the amount of dispersing agent(Dispersant #4).

The amphiphlic dispersing agent adopted silicone to reduce the interfacial energy between powder and polymer resin. Then, good dispersion and better sealant characteristics were observed. In this research, we found out that the optimum dispersing agent is Dispersant #4 and the optimum contents is about 0.28 wt% of added silver-coated copper powder

Table 4. Electrical and mechanical properties of various dispersing agent added silicone sealants.

Dispersants	None	#1	#2	#3	#4	#5
Resistivity ($x10^{-3}$Ω-cm)	2.25	1.06	1.56	0.84	0.53	4.86
Hardness (shore A)	57	57	55	58	57	55
Tensile strength(psi)	275	257	261	238	271	267
Elongation(%)	88	91	96	88	94	108
Viscosity (Poise)	178	382	176	207	164	239
Adhesion strength(B)	5	3	3	3	3	2

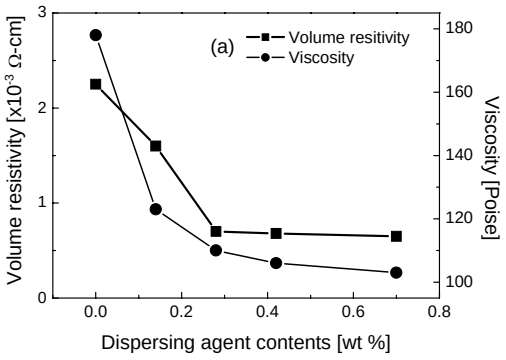

Fig. 1. Volume resistivity and viscosity of silicone sealant with dispersing agent contents(Dispersant #4)

3. Summary

The influence of the silane coupling and dispersing agent on the corrosion stability and the degree of dispersion of EMI shielding silicone sealant, respectively, have been mainly investigated in this work.

Based on these results, it is concluded that corrosion stability can be achieved and the electrical and mechanical properties of EMI silicone sealant can be enhances by silane coupling and well dispersing .

4. References

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