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SNAP CURING ELECTRICALLY CONDUCTIVE FORMULATION FOR SOLDER REPLACEMENT APPLICATIONS

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THE MOST SOLDERING MATERIALS ARE IN THE FORM OF PASTE, WHICH ALL HAS TO CONTAIN:

- HIGH LEVEL OF FUSIBLE METAL POWDERS (SOMETIMES VERY TOXIC),
- FLUXES,
- ACTIVATORS,
- SOLVENTS AND OTHER INGREDIENTS FOR PREPARING PASTE WITH PROPER CONSISTENCY, VISCOSITY AND RHEOLOGY.

DURING SOLDERING PROCESS ONE THE MAJOR CONDITION HAS TO OCCUR - TEMPERATURE HIGHER LIKE MELTING POINT OF SOLDER ALLOY. MOSTLY THIS TEMPERATURE IS AROUND OR OVER 200°C.

TECHNICAL ASSUMPTIONS FOR SOLDER REPLACEMENT TECHNOLOGY:

1.SHOULD TO BE NOT MUCH MORE EXPENSIVE AS NORMAL SOLDERING METHOD IS.

2.NEW TECHNOLOGY SHOULD TO USE THIS SAME PRODUCTION EQUIPMENT AS ACTUAL.

3.NEW TECHNOLOGY SHOULDN'T REQUIRE MORE SPACE AS THE OLD ONE.

4.NEW TECHNOLOGY SHOULD TO BE AS QUICK, AS NORMAL IS.

5.NEW TECHNOLOGY SHOULD TO BE MORE SIMPLY LIKE ACTUAL PROCESS IS.

ADHESIVE BINDER FORMULATION:

- THERMOSETTING UNSATURATED RESIN WITH FREE RADICAL CROSS LINKABLE POLYMER,
- A FREE RADICAL INITIATING AGENT,
- UNSATURATED MONOMER CAPABLE OF CROSS-LINKING THE RIGHT POLYMER,

+ % of thermoplastic resin - for reducing of shrinkage,

+ % of additives and modifiers (wetting agents, adhesion promotors,..).

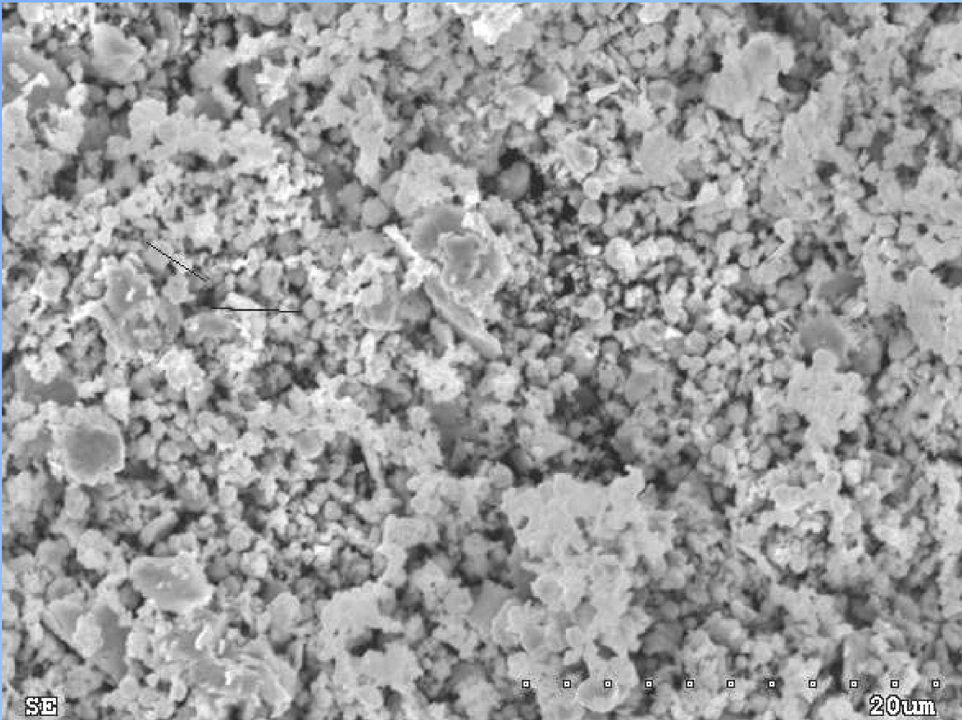
OUR RESEARCH WAS DONE ON THE COMPOSITION WHOSE BASE MATERIAL WAS ESTER OF EPOXY-VINYL RESIN MODIFIED BY AN APPROPRIATE MONOMER DURING THE PREPARATION PROCESS (IN THIS CASE BIFUNCTIONAL OLEFINIC MONOMER WITH GROUP OF PHTHALATE ESTER).

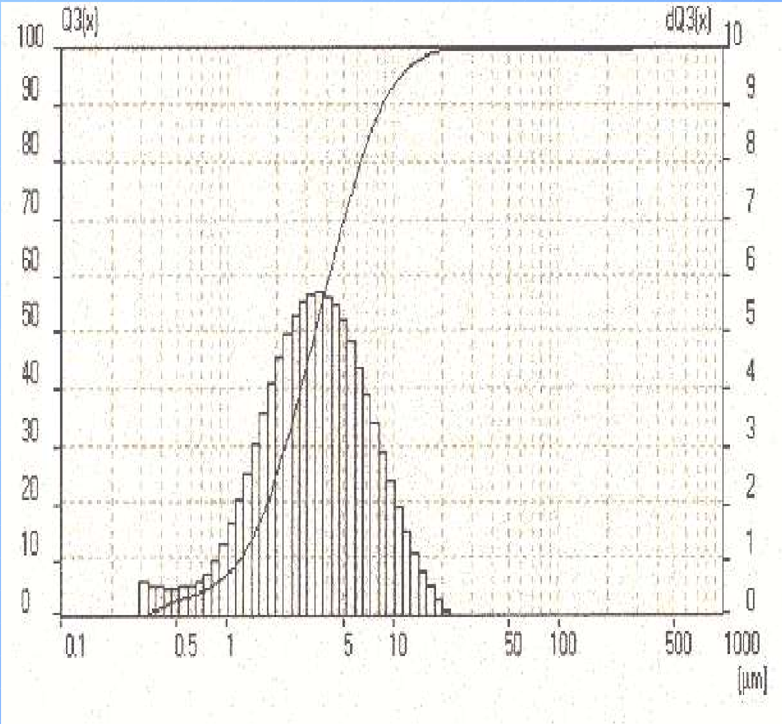
ADHESIVE BASE MATERIAL (***X*** AND ***Y***) CONTAINS NOT ONLY APPROPRIATE POLYMER, BUT ALSO ADDITIONAL MODIFYING AGENTS AND ADDITIVES IMPROVING CERTAIN PROPERTIES (FOR INSTANCE SHRINKAGE AND ADHESION TO SURFACES).

ADHESIVE GEL TIME:

Polymer type	X		Y	
Catalyst type	*Slow*	*Fast*	*Slow*	*Fast*
Gel time (mean value)	9.1	5.6	13.6	10.9
Gel time (values range)	8,2÷10.0	5.0÷6.3	12.8÷14,2	10.0÷11.5

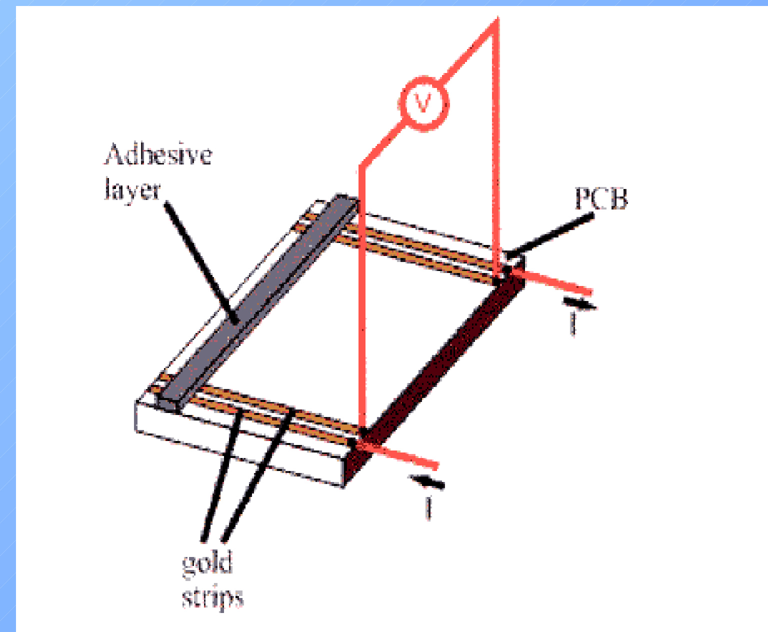
ADHESIVE FILLER





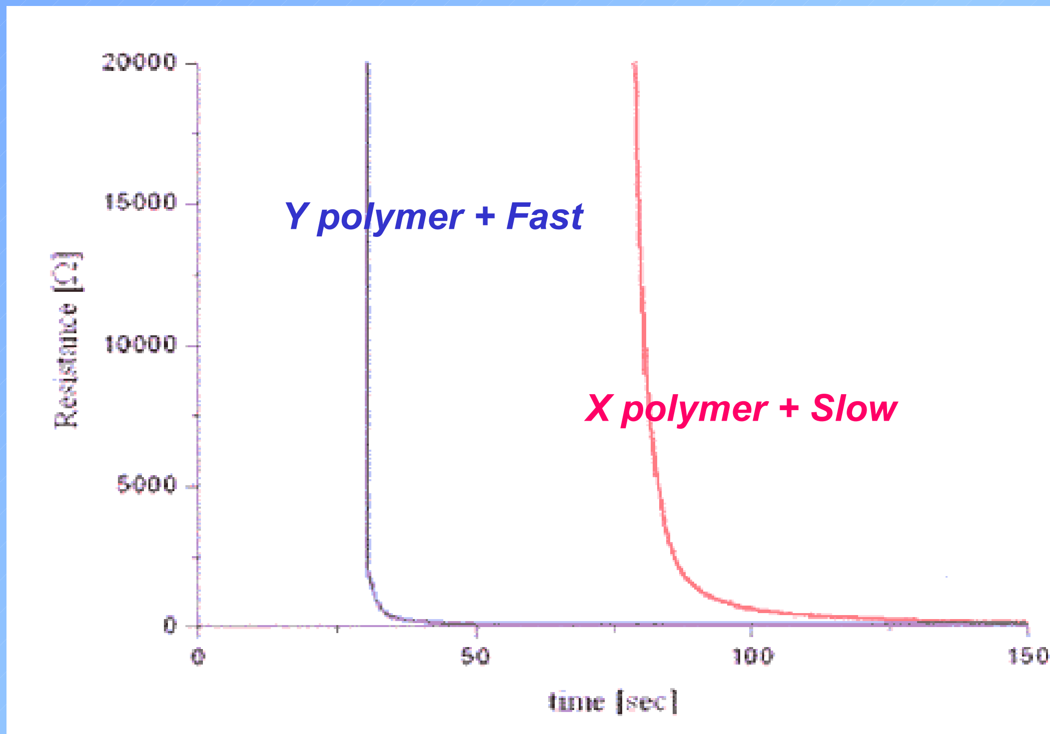
SAMPLES AND TEST METHOD

Samples for all tests were prepared on the basis of PCB FR4 type with four parallel 1mm wide conductive strips. Paths were made as the multilayer of Cu covered by Ni and Au (both layers with thickness of about 0.5µm each).



CURING TIME

samples at room temperature were put in hot (150°C) chamber of an oven. Exactly at that time, the measuring system was switched on



79s for polymer X-type with Slow catalyst,

56s for polymer X-type with Fast catalyst,

62s for polymer Y-type with Slow catalyst,

31s for polymer Y-type with Fast catalyst.

RESISTIVITY

Factors and levels:

- A1 – the X-type polymer
- A2 – the Y-type polymer
- B1 – the Slow catalyst
- B2 – the Fast catalyst
- C1 – low filler content (50 weight %)
- C2 – high filler content (70 weight %).

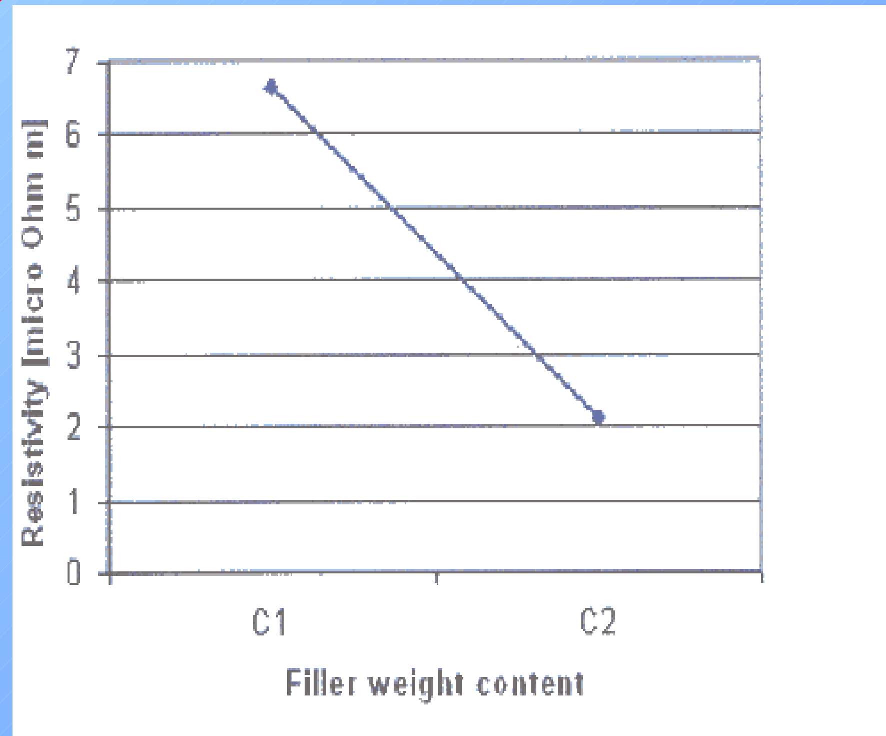
orthogonal array $L_8(2^7)$

Test No	Factors and Interactions							Resistivity [μΩm]
	A	B	AxB	C	AxC	BxC	AxBxC	
1	1	1	1	1	1	1	1	6.24; 4.52; 6.67
2	1	1	1	2	2	2	2	1,47; 1.62; 1.54
3	1	2	2	1	1	2	2	5.88; 5.34; 6.02
4	1	2	2	2	2	1	1	1.86; 2.06; 2.06
5	2	1	2	1	2	1	2	7.15; 6.82; 5.88
6	2	1	2	2	1	2	1	1.89; 1,83; 1.85
7	2	2	1	1	2	2	1	8.35; 8.92; 7.83
8	2	2	1	2	1	1	2	3.16; 2.81; 3.10

ANALYSIS OF VARIANCE

Factor	*SS*	*ν*	*V*	*F*	*P%*
A	8.532	1	8.532	31.15***	5,70
B	4.092	1	4.092	14.94***	2,64
C	123.171	1	123.171	449,6***	84.96
AxB	2.400	1	2.400	8.76***	1.47
AxC	1.628	1	1.628	5.94**	0.94
BxC	0.002	1	0.002		
AxBxC	0.451	1	0.451		0.12
Total	144.651	23			100.0
e	4.383	16	0.274		4.17

C – filler content



CONCLUSIONS

- PRESENTED RESULTS SHOW THAT INVESTIGATED CONDUCTIVE COMPOSITION IS SNAP CURING FORMULATION. THE DYNAMICS OF GELLING PROCESS (AND HARDENING) IS EQUIVALENT OF DYNAMICS IN THE PROCESS OF SOLIDIFICATION IN METAL SOLDERS AS THEY COOL DOWN.
- PRESENTED RESEARCH RESULTS REFER AT THE MOMENT ONLY TO TWO EPOXY-VINYL RESINS WITH ONE TYPE OF CONDUCTIVE FILLER OF SPECIFIC PARTICLE SIZE. NATURALLY, THIS DOES NOT RULE OUT FURTHER RESEARCH ON IMPROVING THE BASE MATERIAL PREPARATION TECHNOLOGY AND OTHER CHOICE OF MODIFIERS INFLUENCING TECHNOLOGICAL PROPERTIES AND TECHNICAL PARAMETERS OF THE END PRODUCT.
- NEW AND POORLY INVESTIGATED MATTER YET IS THE INFLUENCE OF CONDUCTIVE FILLER PARTICLE SIZE ON THE PARAMETERS OF THE END PRODUCT. CURRENTLY AVAILABLE TECHNIQUES OF OBTAINING SILVER FILLERS WITH PARTICLE SIZE OF ABOUT 20nm WILL BE ABLE TO OPEN TOTALLY NEW POSSIBILITY.