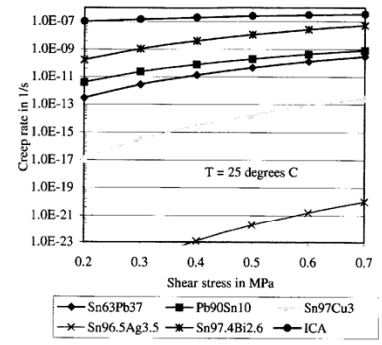
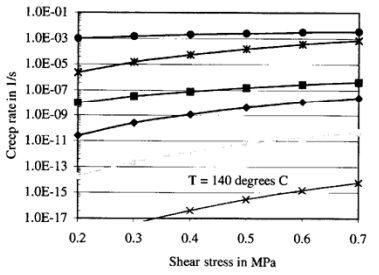
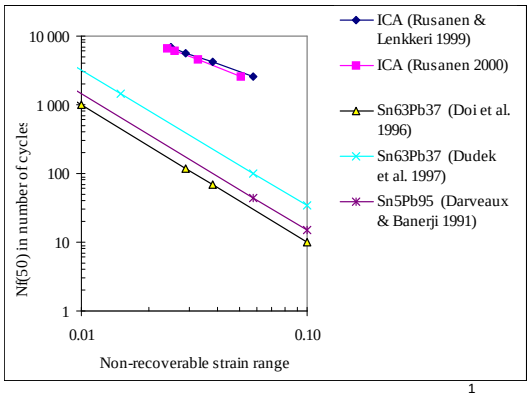
6.4 Creep & Coffin-Manson Lifetimes: Comparisons with Solder (Rusanen)



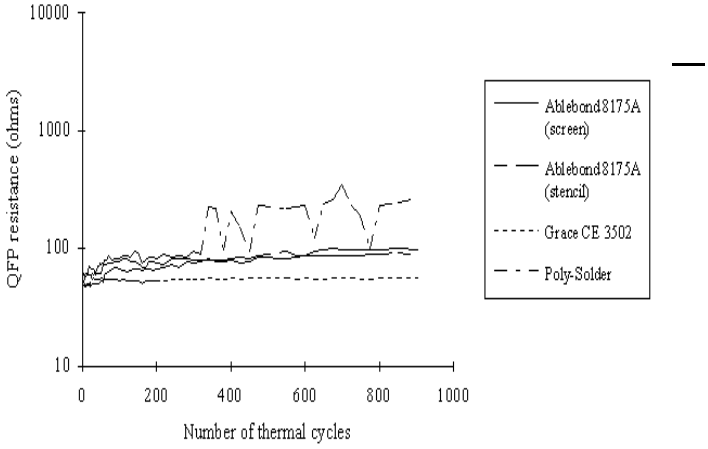




1

Figure 8. Creep rates of joining materials at temperatures of 25°C and 140°C.

6.5 Thermomechanical cycling



Resistance of 160 QFP adhesive joints on copper PCBs during temperature cycling test, -40 to 85 °C, 1000 hours according to test condition E.Average of six samples

Filler movement

- Caused by thermal mismatch
- Electrical resistance increase and microcracks formation

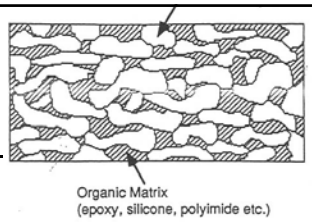


Figure 5. Schematic of the microstructure of metal powder filled conductive adhesive with metal powders in contact.

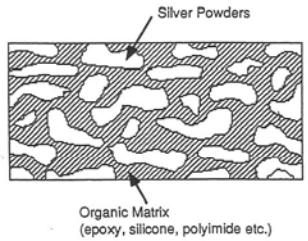
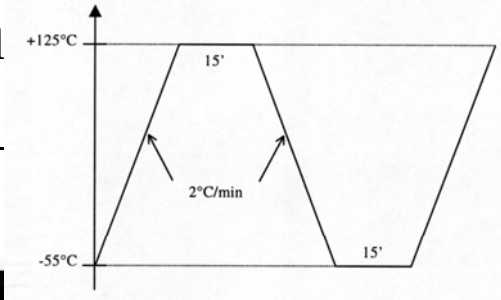
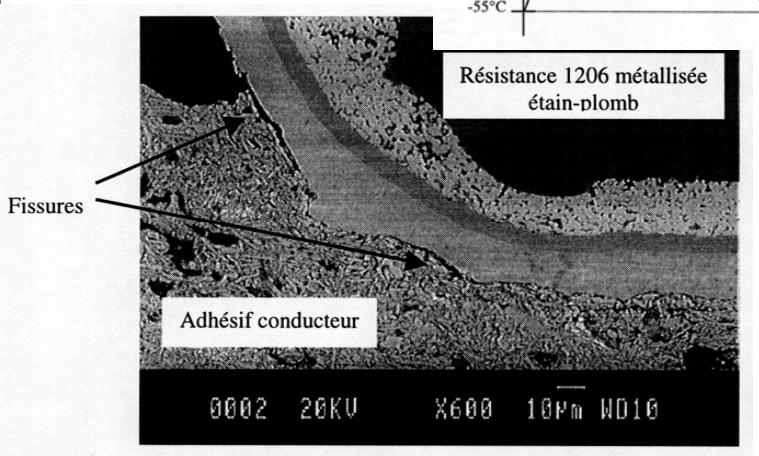


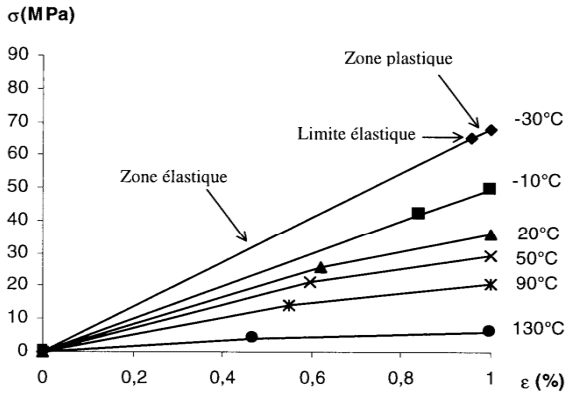
Figure 6. Schematic of the microstructure for a highly compliant conductive adhesive after severe thermal cycling, showing loss of intimate contact between the metal particles.

Thermo-mechanical cycling: 100 cycles

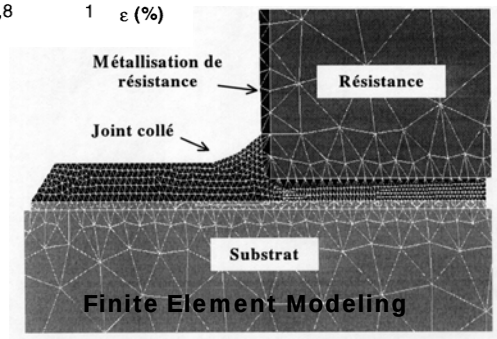
(Perichaud/Fremont)





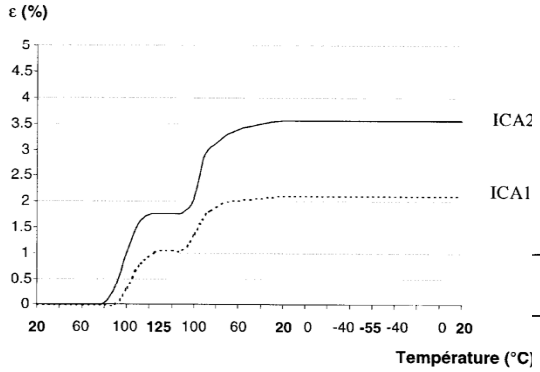


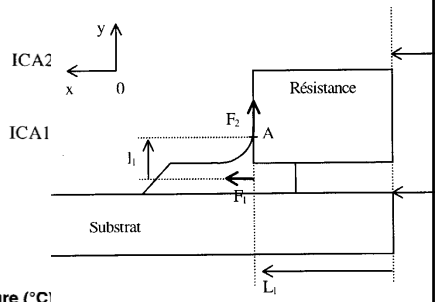
Lifetime modeling requires thermo-mechanical materials properties (Perichaud/Fremont)

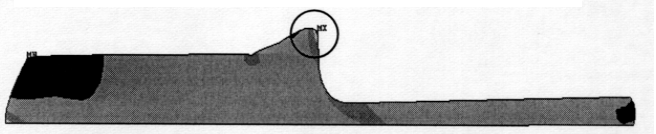


4/27/2009

Expect maximum thermal stress at low T, but plastic deformation max at high T. Failure due to accumulated plastic strain.







Note $T_{max} > T_g$

6

7. Thermal Effects

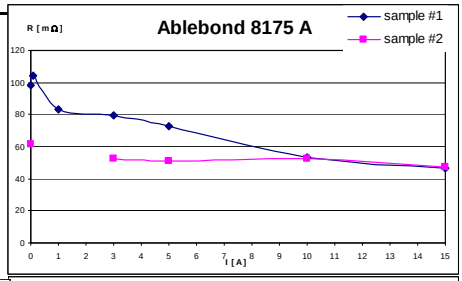
7.1 High current effects
7.2 Thermal Resistance

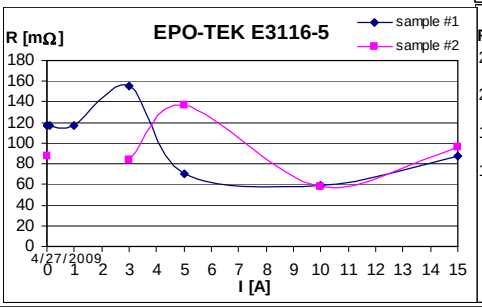
7.1 High Current Effects

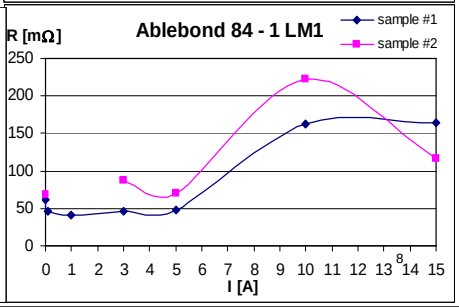
ICA	Resist #1	Resist #2	Temp
8175A	53.0 mΩ	52.4 mΩ	52°C
841LM1	163.4 mΩ	223 mΩ	144°C
E3116-5	59.7 mΩ	57.8 mΩ	58°C

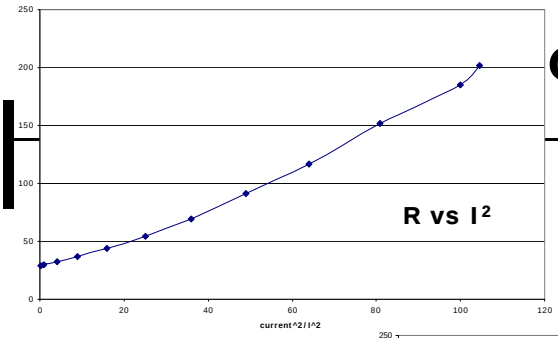
ICA surface temperatures at 10A.

50mΩ → 5W → 2W/mm3 (2kW/cc) → 50°C
200mΩ → 20W → 8W/mm3 (8kW/cc) →140°C

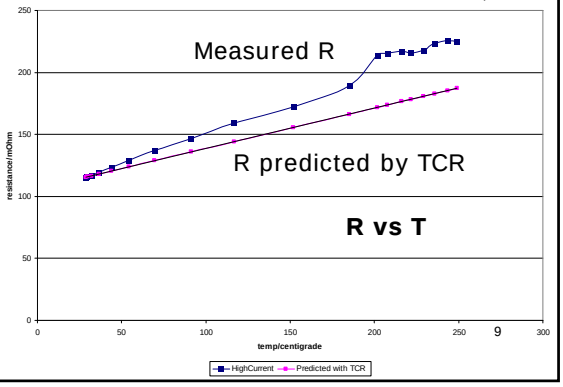








Current (to 10A) and surface temperature (thermocouple measurement)



8. Miscellaneous & New Development

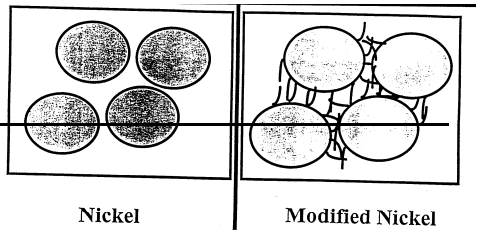
Manufacturing Enhancements

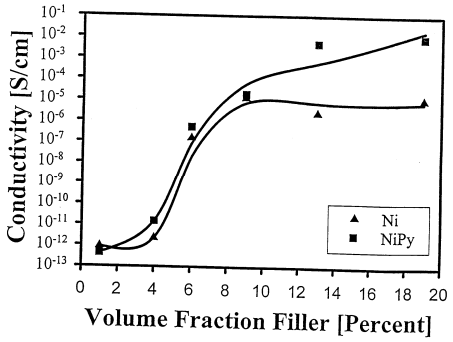
- **Intrinsically conductive polymers**
- **Carbon nanotubes (CNTs)**
- **Flake orientation**
- **Magnetic field**
- **Electrical field effects**

Imprint boards

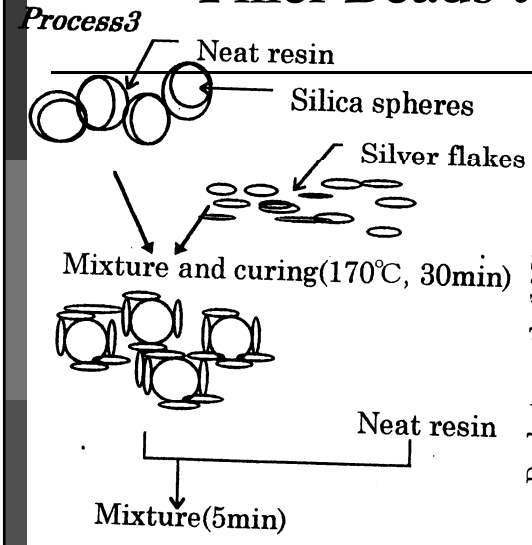
Flexible electronics

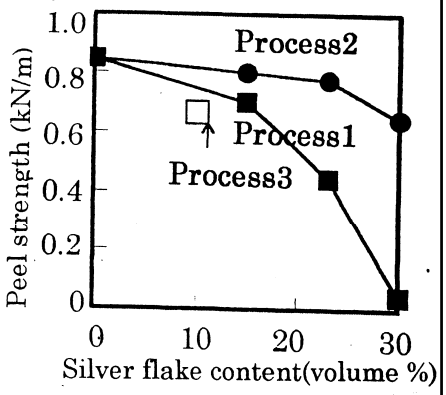
Add Inherently Conducting Polymer (Polypyrrol)



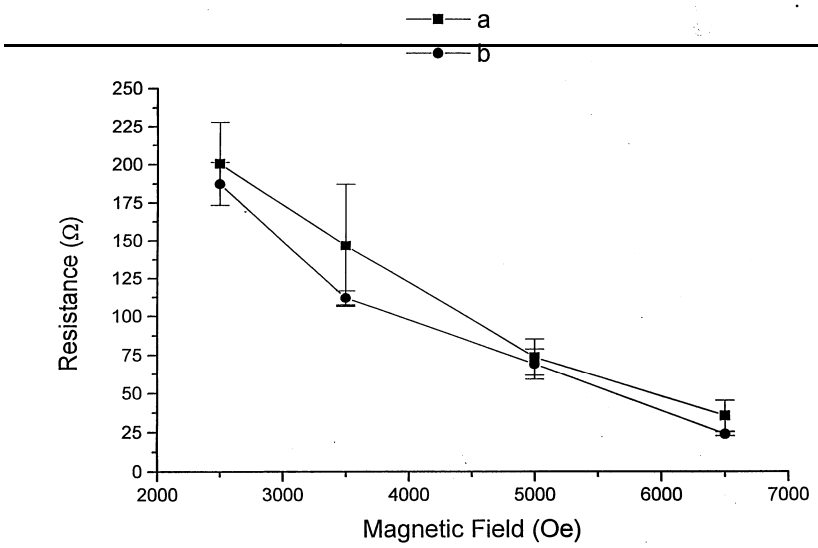


Filler Beads to Orient Flakes

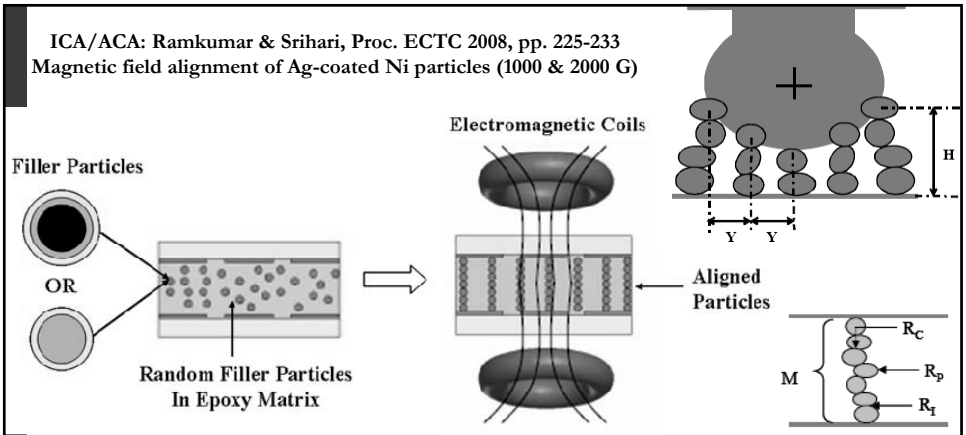


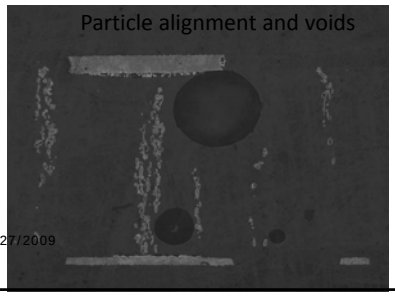


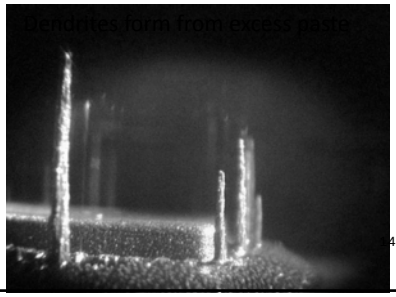
Magnetic Ordering: Ni Rods



ICA/ACA: Ramkumar & Srihari, Proc. ECTC 2008, pp. 225-233
Magnetic field alignment of Ag-coated Ni particles (1000 & 2000 G)







Electric Field Effects in Cure

Apply electric field to uncured ICA
- sudden decrease in R
- increase in current flow

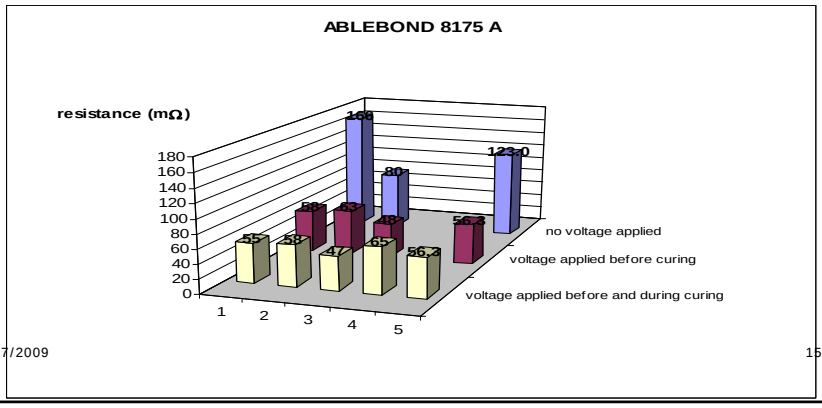
Alignment effect?

Silver migration effect?

Is cured resistance lowered by field?
- Field applied before cure only
- Field applied during cure too

50volt/mm applied for 15 minutes before cure

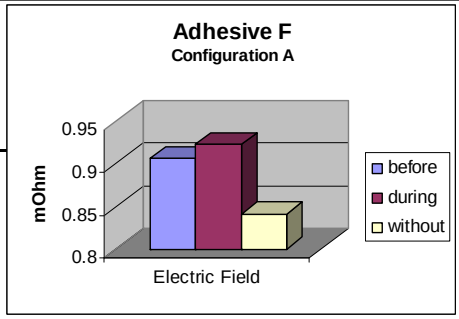
Cure: (a) no field & (b) 50V/mm during cure



Adhesive "F"

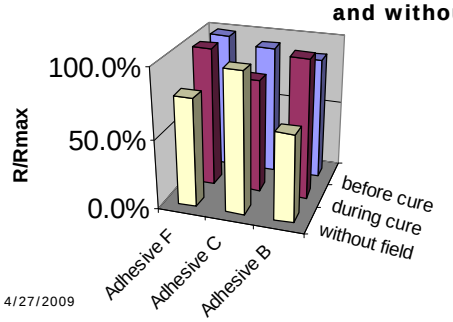
Only adhesive F was used for this test.

All measured resistances were in a range of 0.7mOhm to 1.2mOhm



Adhesive F **Configuration C**

No significant difference with and without applied field.



There was no significant drop in volume resistance of the cured samples, whether supplied with an electric field before or during cure, or not.