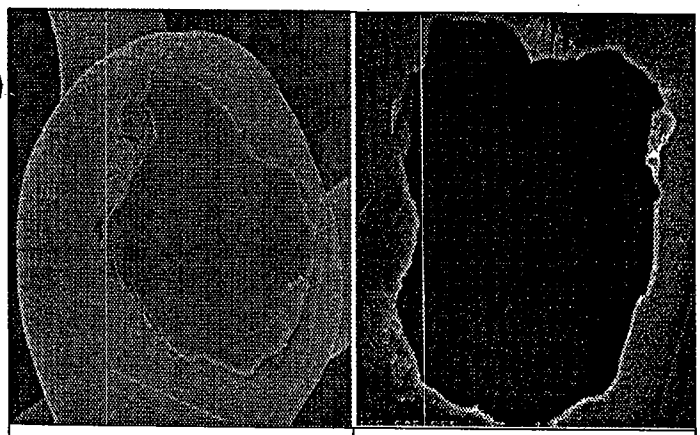
PROCESS BULLETIN No. 2

Tech Process Bulletin: Metal Lift

DEFINITION

Metal lifts (Pad Peels) are delamination failures that occur when layers of metallization fail to adhere to each other or to the underlying oxide or barrier metal layers.

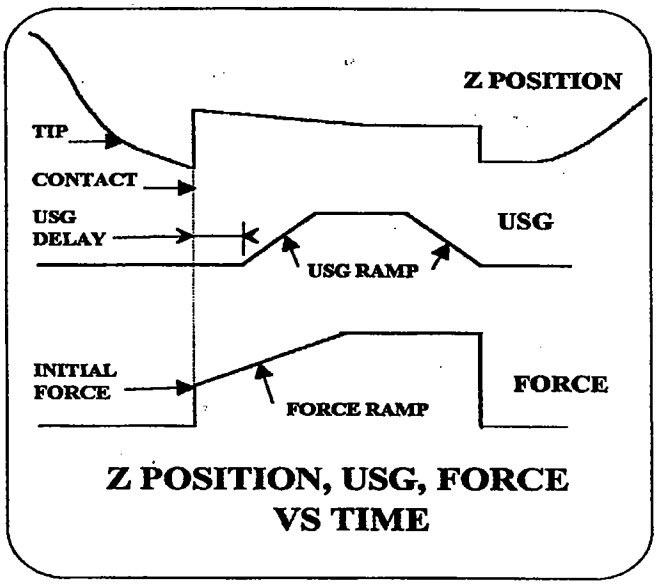
During wire bonding the action of the wirebonder fractures the adhesion layer resulting in a delamination. The ball bond and bond pad lift during the motion from first to second bond. The micrograph below is a metal lift. The bond pad appearance shows the metallization void. The missing metallization adheres to the underside of the ball bond. Close examination of the metal remaining on the bond pad often shows that the delamination extends underneath the remaining bond pad. The residual material buckles up forming a void.



Bottom Surface of Ball | *Bond Pad*

WHEN THEY OCCUR

Metal lifts generally occur in multi–layered bond pad metallization. Often they are lot related, occurring in some lots from a wafer foundry and not in others. It is not unusual for lots of the same device produced at different foundries to have different characteristics.



Z POSITION, USG, FORCE VS TIME

NEW SOFTWARE VARIABLES

We have developed a new software (6.03 Series) to reduce the occurance of metal lifts. The software adds an additional level of control during the bonding process. The above timing diagram illustrates the effects of the new variables. Both ultrasonic power and bond force can

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be linearly ramped, with programmable ramp rates. A programmable time delay before the start of ultrasonics allows time for thermocompression deformation to occur. The result is a larger contact crosssection before ultrasonics energy is applied. This reduces the ultrasonic power per unit area.

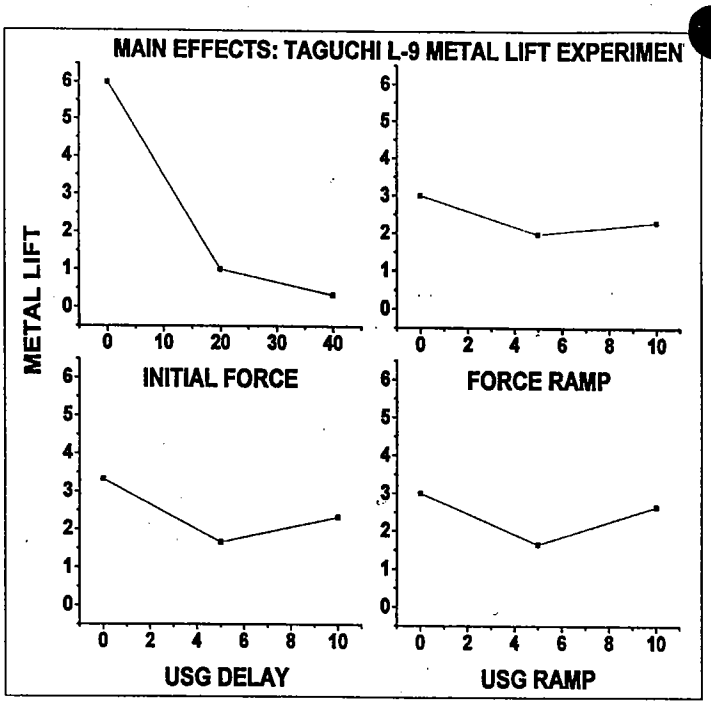
RESULTS OF DESIGNED EXPERIMENTS

Designed experiments, on lift sensitive devices, have been performed in the field with an experimental version of the new software. The following table shows the experiment matrix and results. Each cell represents 13280 wire bonds. As a result of the experiment confirmation runs of approximately one million wires have been reported with zero pad peels.

If an application requires, the designed experiment below is a good one to replicate initially. Run the same sample quantity for each of the 9 cells in the run sequence shown. Randomization is not necessary. Each variable has three levels. The average number of defects at each variable level is graphed. Regression can be used to determine the significance of each variable.

TAGUCHI L-9 METAL LIFTS

INITIAL BOND FORCE	FORCE RAMP UP	USG DELAY	USG RAMP UP	METAL LIFTS PER 13280 BOND PADS
0	0	0	0	8
	5	5	5	4
	10	10	10	6
20	0	5	10	14
	5	10	0	1
	10	0	5	1
40	0	10	5	0
	5	0	10	1
	10	5	0	0



CONCLUSIONS

When metal lifts are detected we recommend the following:

- The best way to resolve the problem requires the wafer fab to change the metallization.
- Upgrade to Series 6.03 Software.
- Start with the following parameters:
  Initial Bond Force = 20 grams
  USG Delay = 5 counts (2.5 mS)
  USG Ramp = 5 counts (2.5mS)

These recommendations represent a good starting point. However, additional designed experiments may be required to resolve problems with specific applications.

Replication of the experiment described in this bulletin is a good first choice for a designed experiment.