HI-REL LABORATORIES, INC.

DPA Results/Trends and SEM

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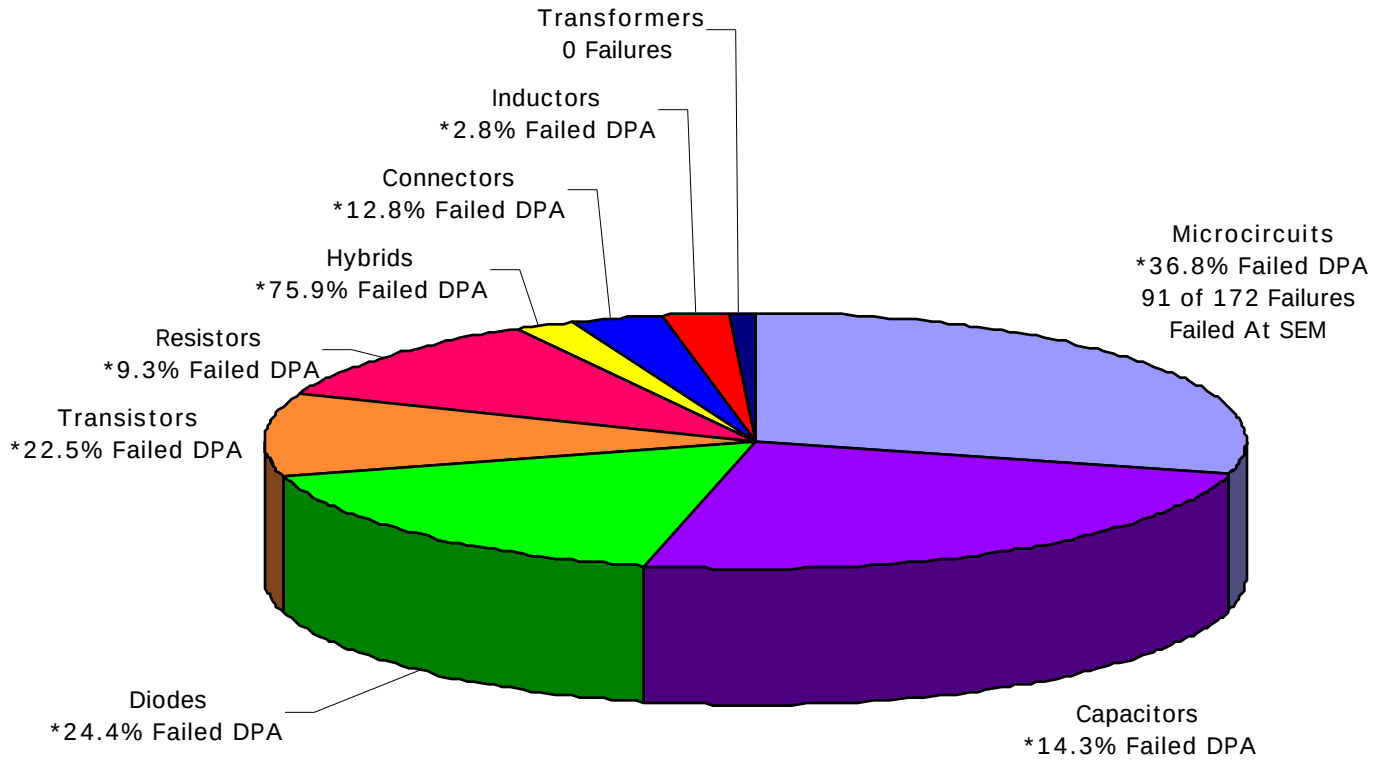
To The Space Parts Working Group

April 26, 2000

Historical DPA Results

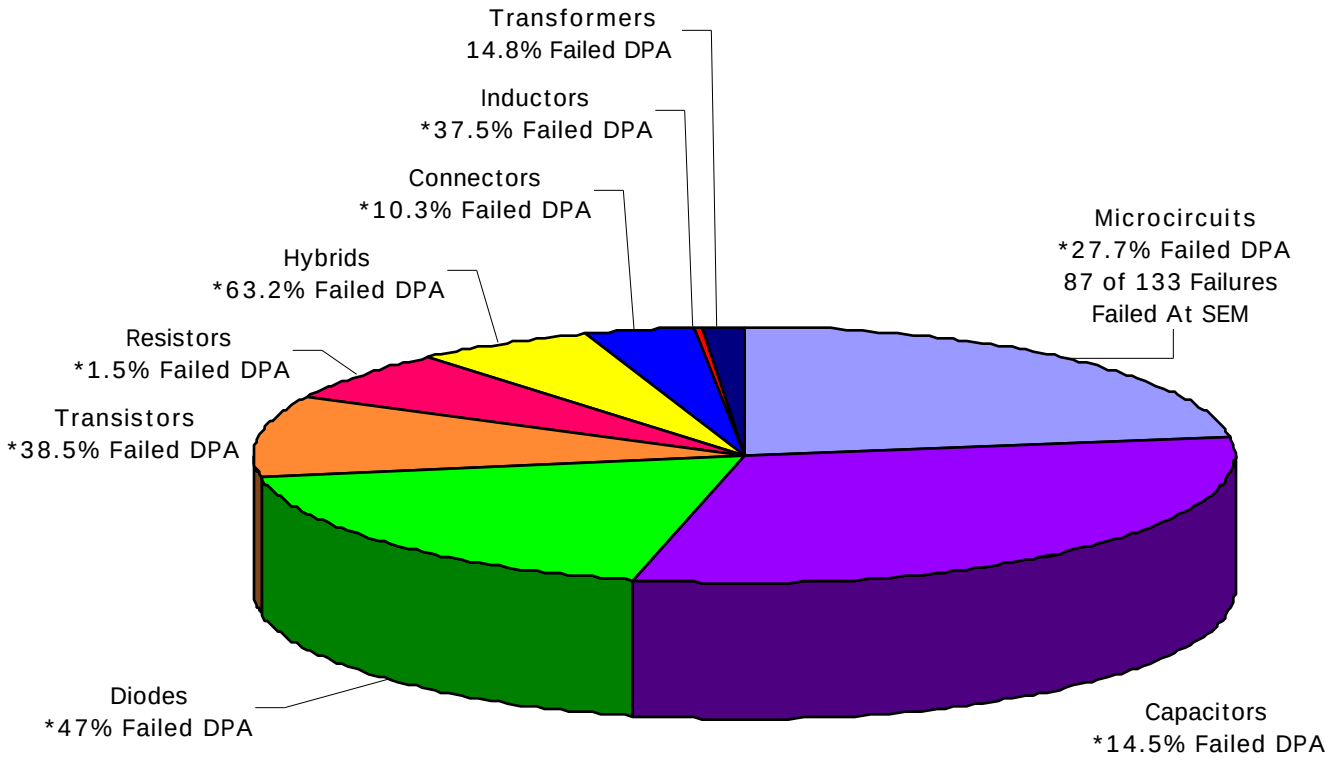
- We'll look at data retrieved from all DPA's performed in 1989.
- Next we'll compare that with data from 1999.
- Last we'll examine the results from just under 11,500 DPA's from 1989,90,& 97-99.

DPA Results Within Part Type Distribution
For 1989 (1717 DPA's Performed)
Overall DPA Failure Rate Was 22%



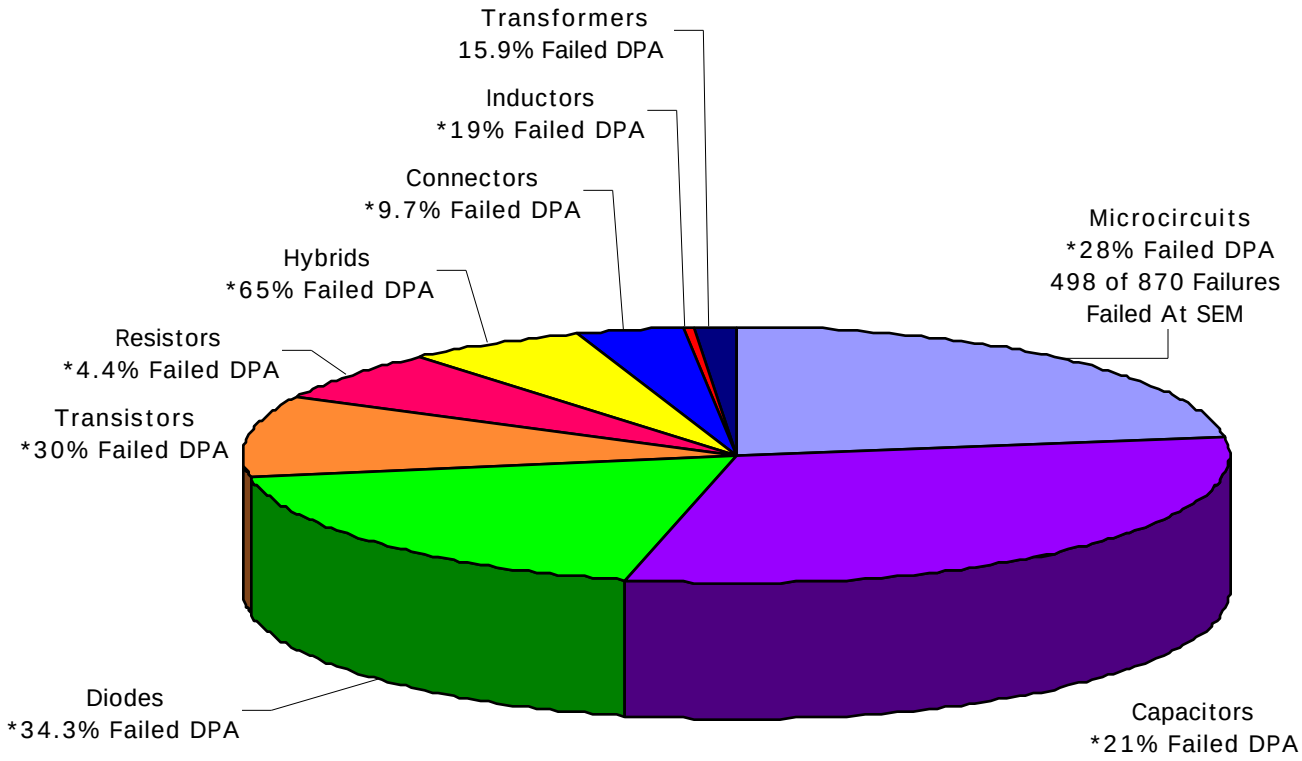
*Denotes DPA Failure Rate

DPA Results Within Part Type Distribution
For 1999 (2246 DPA's Performed)
Overall DPA Failure Rate Was 26.5%



*Denotes DPA Failure Rate

DPA Results Within Part Type Distribution
For 1989-90, 97-99 (11,442 DPA's Performed)
Overall DPA Failure Rate Was 25.4%



*Denotes DPA Failure Rate

DPA Trends

- Hybrids continue to fail for multiple causes. The most common are metal scratches, foreign material, SEM step coverage, Bond Pull, and Die Shear.
- Glass bodied diodes continue to exhibit inadequate die attachment at both cross-section and scribe and break.

DPA Trends Cont.

- Transistors continue to reveal significant dropout at bond pull and SEM.
- Microcircuits continue to push the technology envelope particularly at SEM. Triple level metal devices are more commonplace and require significant etching skills at glassivation removal. More on SEM later…..

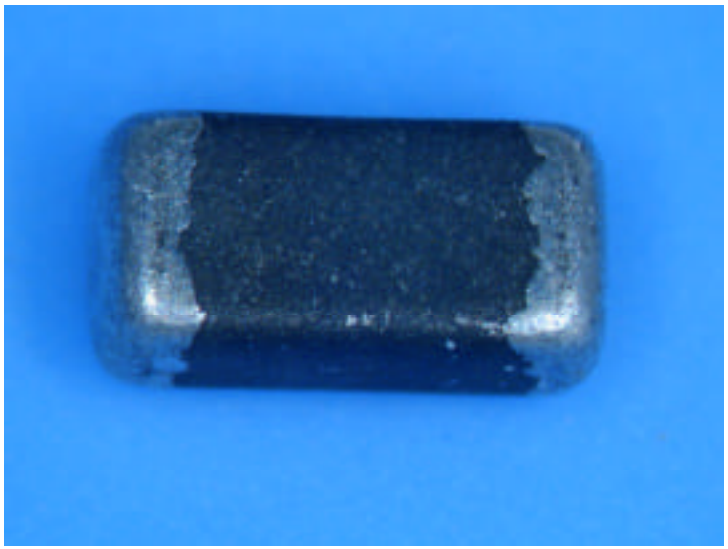
DPA Trends Cont.

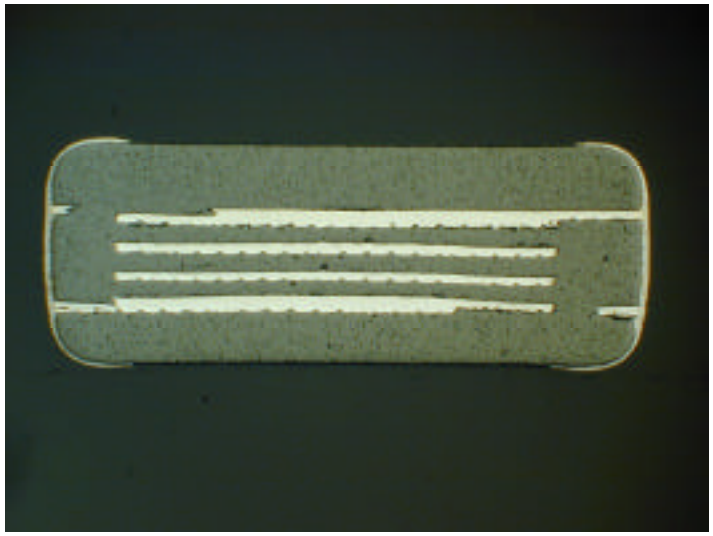
- New Part construction types are showing up more regularly particularly in passive parts ie.Chip Tantalum Caps and Chip Inductors built like Ceramic Chip Caps.
- The DPA specifications are having trouble keeping up with these changes.
- Mil-Std-1580B is supposedly breathing again but don’t hold your breath.

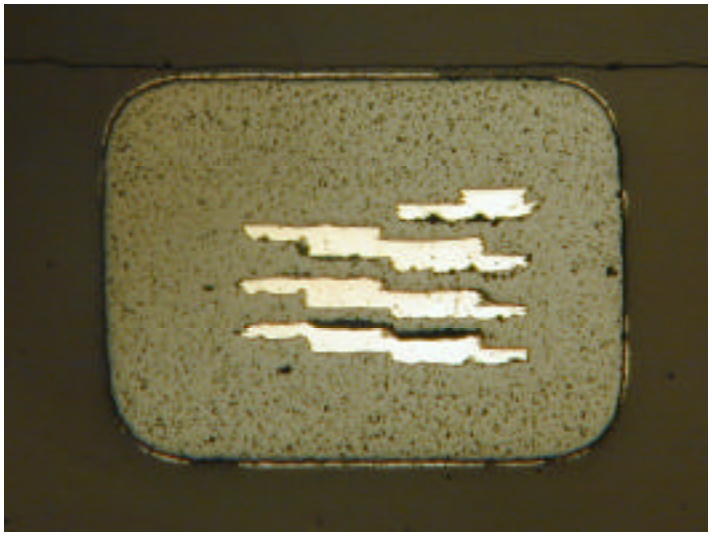
DPA Trends Cont.

- We are not seeing the rush to PEMs that was originally heralded by faster, better, cheaper!
- <50 DPA’s of PEMs were performed by Hi-Rel in 1999.
- Hi-Rel is witnessing the re-introduction of DPA testing where it had been previously been eliminated.

Chip Capacitor? No It's an inductor!

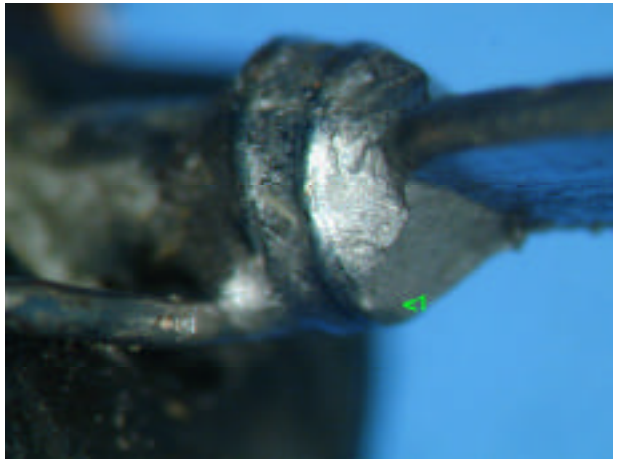


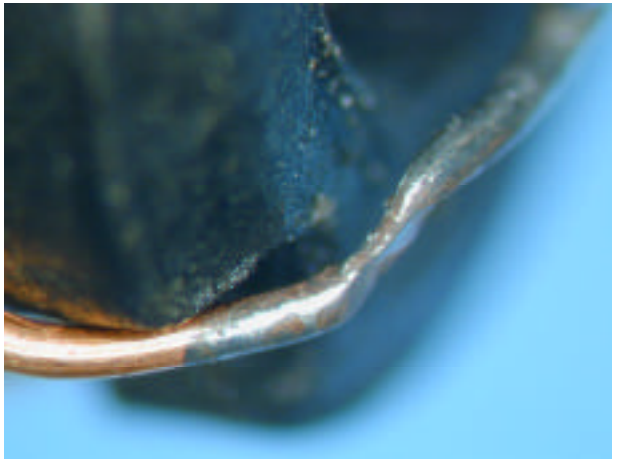


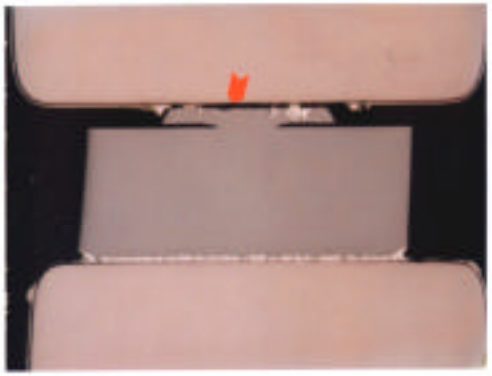


We’re Seeing Problems In Magnetics

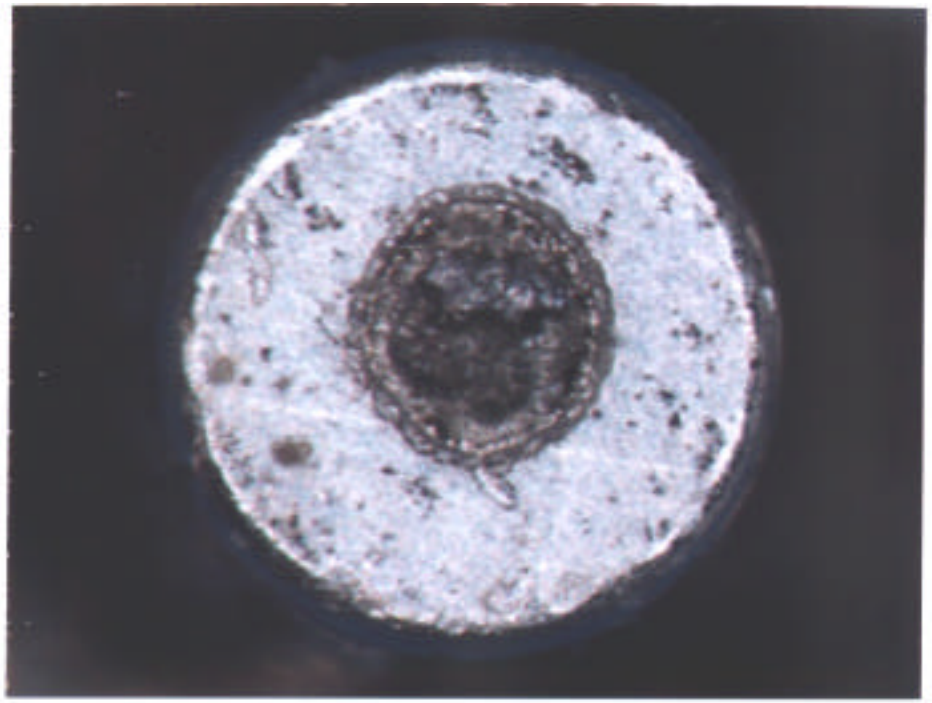
<3 Wire Wraps and Pinched Wires







Glass Bodied Diodes continue to show inadequate die attachment.



What about SEM?

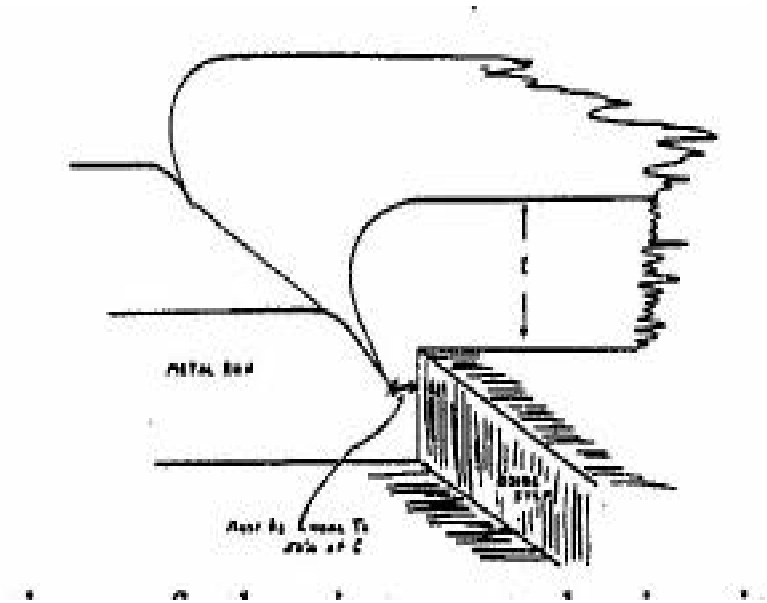
- Mil-Std-883 Method 2018 has not kept up with current technologies.

- A large number of DPA's of microcircuits fail DPA due to thinning metallization. The majority of the time, additional cross-sectioning must be performed and the parts are bought off upon MRB. But that creates a lot of extra work that might not be necessary.

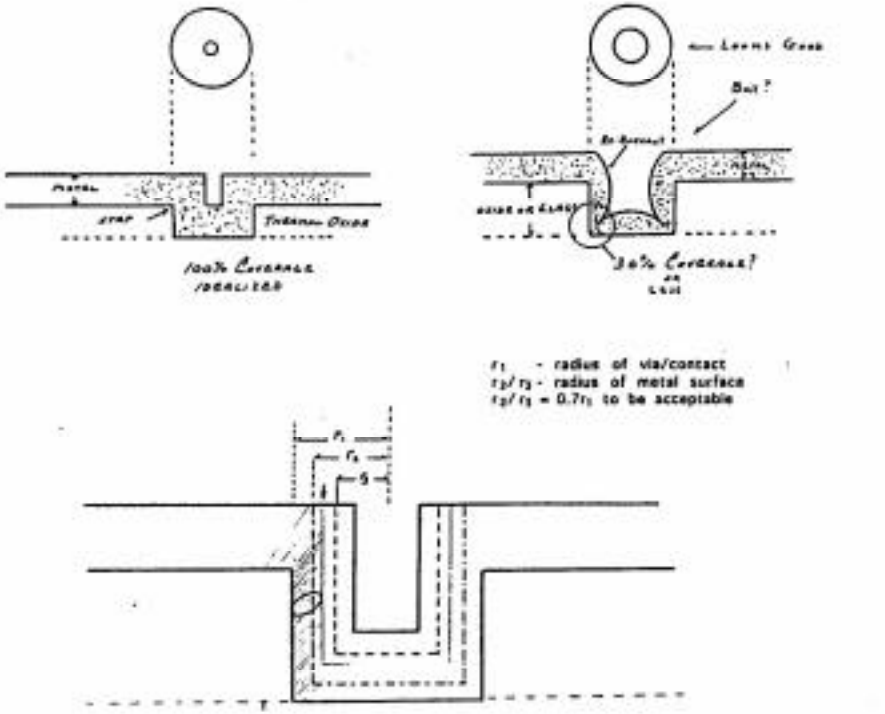
What's the problem?

- In a simple single level metal device, the amount of thinning/metal coverage identified at a metal step corresponds directly to the metal line's cross-sectional area.
- In devices with circular or multisided contacts and vias, the thinning noted at SEM inspection does not correllate directly to the cross-sectional area.
- When thinning is noted in the circular or multisided via/contact structures, it is almost always required to cross-section the device to determine the cross-sectional area at the metal steps in question. This increases cost and time requirements.

Examples of Step Types



Simple Metal Line Step

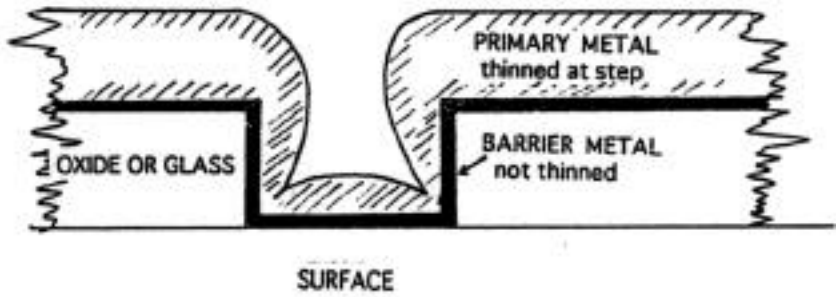


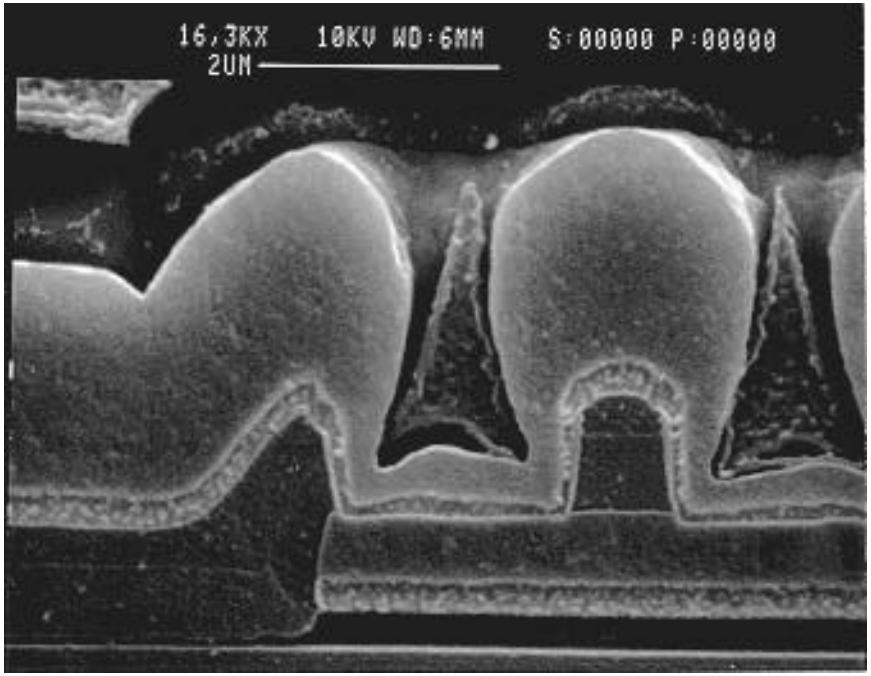
Circular Contact Structure

What's the problem? Cont.

- Additionally, the specification does not address the appropriate approach for calculating the cross-sectional area for different geometries.
- Although precluded by the specification, barrier metal coverage is often used to justify use of the device.
- Different organizations interpret the spec. differently. Some go by metal coverage noted at SEM inspection while others utilize cross-sectional area.

Barrier Metal Illustration



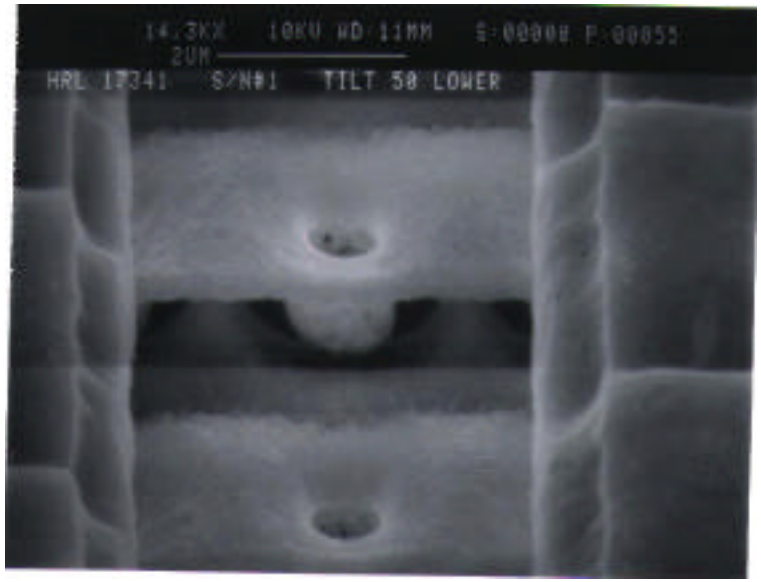


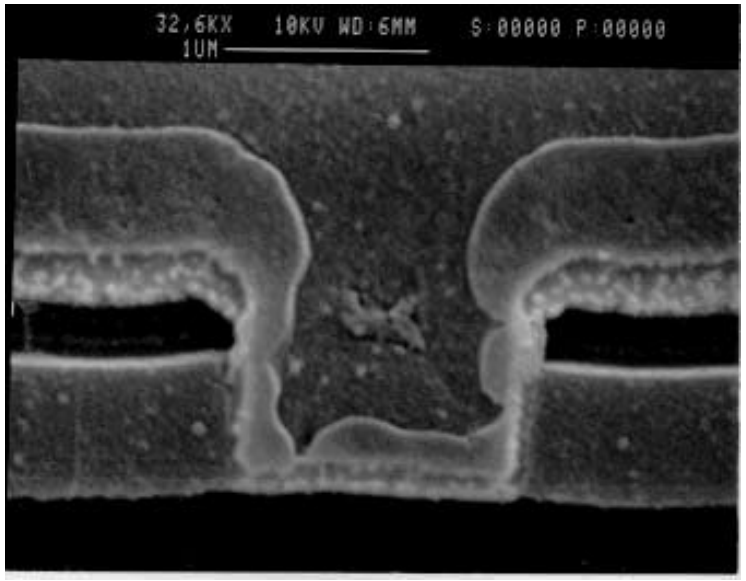
Is there a solution?

- Hi-Rel proposes that a new metal coverage criteria be designated for devices with circular or multisided contacts or vias. Currently, 2018 calls out 30% cross-sectional area. We propose a minimum limit of 20% combined metal coverage when viewed from above during SEM inspection. Anything worse would fail inspection and require cross-sectioning to determine suitability for use.
- Additionally, Hi-Rel believes barrier metals should be included in this measurement.

Is there a solution? Cont.

- When metal coverage can not be determined, cross-sectioning shall be required.





In Summary I’d Like to Leave you With a Thought

- The greatest obstacle to progress is not ignorance, but the illusion of knowledge.