What's Your PCB Assembly IQ?

Marissa Oskarsen & Chrys Shea, Printed Circuit Girls and Geeks

Quiz #3 – Design for Conformal Coating

Back by popular demand….more on conformal coating! Ya'll liked last month's conformal coating questions in our corrosion quiz so much that you asked for more. So, we made a special DFCC (Design for Conformal Coating) quiz just for you.

Test your expertise by taking this 10-question quiz to determine your ConCoat IQ. If you didn't take the most recent corrosion quiz, you might want to do it right now – we guarantee it will improve your score on this one. http://www.pcb007.com/pages/zone.cgi?a=91237

Part 1 - True or False?

1. Conformal coating a PCBA will prevent corrosion.
2. Conformal coating will prevent tin whiskers from forming and shorting out electrical circuitry.
3. Conformal coatings can also act as underfill, eliminating a process step and reducing manufacturing cost.
4. Connectors should not be conformal coated.
5. No-clean flux residues must be removed prior to coating.
6. Conformal coatings are never reworkable.

Part 2 - Multiple Choice

7. How are conformal coatings applied?
    a. Spray
    b. Brush
    c. Dispense
    d. Dip
    e. Jet
    f. Film
    g. Vapor Deposit
    h. Plasma coat
    i. The obvious choice - All of the above
8. PCB assemblies can be selectively coated to protect specific areas and expose others. What is the ideal minimum distance between areas to be coated and areas that are not to be coated:
    a. 0.5mm (20mil)
    b. 1mm (40mil)
    c. 2.5mm (100mil)
    d. 5mm (200mil)
    e. All of the above
    f. None of the above
9. What's the tallest component that can be conformal coated?
    a. 2.5cm (1.0in)
    b. 3.8cm (1.5in)

c. 5.0cm (2.0in)
d. 6.4cm (2.5in)
e. 7.5cm (3.0in)
f. All of the above
g. None of the above

10. How thick is the typical conformal coating?
    a. 25µm (1mil)
    b. 50µm (2mil)
    c. 75µm (3mil)
    d. 125µm (5mil)
    e. 200 µm (8mil)
    f. All of the above
    g. None of the above

ANSWERS

1. **FALSE.** While most conformal coatings help deter corrosion, the ultimate causes of corrosion may exceed the coating's protective ability. Remember last month's quiz? We said conformal coatings help prevent corrosion, not that they absolutely prevent it (just a slight trick question). We even showed you pictures of corrosion that formed over and under conformal coatings.

   If you got this one wrong (and you want a positive score on this quiz) you should stop here and go back to last month's quiz right now. http://www.pcb007.com/pages/zone.cgi?a=91237

   But if you got this one correct and just want to see those gnarly corrosion photos from our friend Cheryl at DfR Solutions again, here they are:

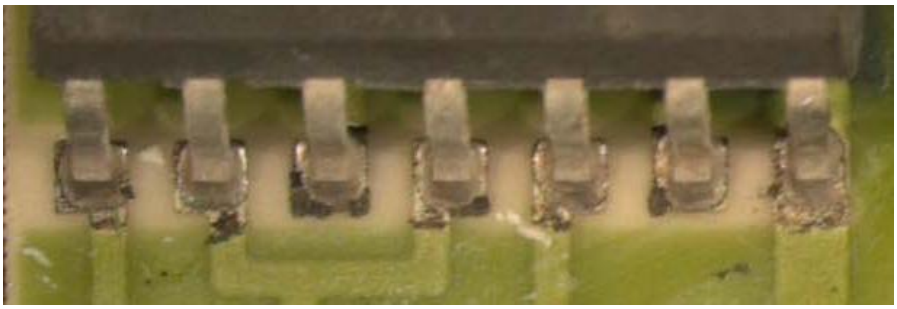

Figure 1. Sulfur (creep) corrosion UNDER conformal coating

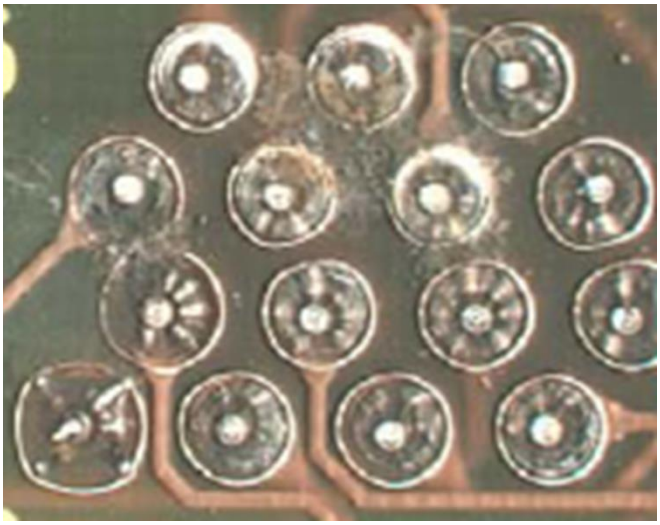

Figure 2. Dendritic growth OVER conformal coating

2. **FALSE.** Early on in the studies of tin whiskers, it seemed that conformally coating PCBs would help slow the process. But more recent studies, using more representative test vehicles, coatings and application methods, have shown that most conformal coatings do not stop whisker growth.

   The University of Maryland's Center for Advanced Life Cycle Engineering (CALCE) presented their findings in "*Assessment of Tin Whisker Mitigation for Conformally Coated SnPb Asemblies,*" published in 2012:
   http://www.calce.umd.edu/tin-whiskers/presentations/CALCE-conformal-coating-study.pdf
   There are some pretty cool SEM pictures of tin whiskers in it.

   A quick summary can be found right here in the pages of our own PCB007 newsletter:
   http://www.iconnect007.com/pages/zone.cgi?topic=0&artcatid=0&a=86174&_pf_=&artpg=8&artid=86174&pg=1

   The study tested acrylic, silicone, urethane, parylene and ALD-cap, a flexible ceramic coating that is vapor deposited. The only coating that did not show whisker penetration was the parylene. You might recall that parylene is one of the most expensive conformal coatings out there. Why is it you always get what you pay for?

3. **FALSE.** While some coatings do wick under components as they flow across the PCB, they do not have the same mechanical properties as underfill and will not protect the solder joints from thermal or mechanical stresses.

   Conformal coating should never, ever, ever be considered a substitute for underfill.

4. **TRUE.** If you put coating over the connector pins or into the sockets, you wouldn't be able to actually use the connector, would you? Duh. But it's not just about keeping it off of pins or

receptacles. If the connectors aren't sealed, the coating will flow under them and wick up into them. Connectors can be selectively coated around in some application processes or masked off in others. And special coating gels can keep flowing coating material out from underneath them.

A new class of nanocoatings is emerging that can be used on connectors and even optical components. While they're a little beyond the scope of the traditional conformal coatings we're discussing here, they are really cool (waterproofing smartphones and tablets is cool in our book). DfR's Cheryl Tulkoff gave a great presentation on them at last month's IPC Electronic Systems Technologies Conference. Contact her if you are interested in more info: ctulkoff@dfrsolutions.com.

DFCC tip: Group selective or masked areas together to simplify the manufacturing process. Also, if there are areas where it doesn't matter if they're coated or not, point those out to the manufacturing engineers; they will thank you for it.

5. **FALSE.** While it is advisable to remove flux residues to facilitate good adhesion of the coating, it is not absolutely necessary, as some coating-flux combinations are 100% compatible. Unfortunately, no-clean fluxes are not formulated with concoat compatibility in mind, so finding the right combinations are often the result of a trial and error testing process, either by the PCB assembler or the conformal coating supplier.

   There are a couple added elements of risk in coating over no-clean flux residues:
   - If one of the chemical formulas changes even just a little bit, its compatibility may be compromised.
   - As we pointed out in the corrosion quiz, no-clean flux residues can cause corrosion depending on their end-use environment. If corrosion prevention is the primary reason for coating, think twice about leaving those flux residues behind.
   - Compatibility requirements limit the material options for both solder paste and concoat, potentially precluding certain process or cost improvement opportunities in the future.

6. **FALSE.** Some are rework-friendly, enabling repair of defective joints or coatings:
   - Acrylics and silicones are typically reworkable
   - Polyurethanes and epoxies are difficult to rework
   - Parylene and other vapor deposited coatings are not reworkable at all

   Reworkability should be one of many considerations in selecting a conformal coating material. Our last quiz (eye roll…here we go again!) touched on some of the operating environment considerations. If you are so incredibly intrigued with the fascinating world of conformal coating options that you hunger for more information, download this really good overview document from DfR Solutions:
   http://www.dfrsolutions.com/wp-content/uploads/2012/06/Conformal-Coating-Why-What-When-and-How.pdf
   It's got comprehensive information on concoat material characteristics, selection criteria and application methods, and it's a very easy read.

7. **I. All of the above.** That was humorously easy, but it was to make a serious point. All these coating processes have different application tolerances, so design considerations for each can vary considerably. It's wise for designers to verify their assemblers' conformal coating capability

and keep within the design guidelines provided.

What happens when we violate design guidelines? Costs got up, quality goes down, fingers start pointing and resumes start circulating. All that ugliness can be avoided by adhering to your manufacturers' guidelines - like you you want your concoat to adhere to your PCBA.

8. **B, C or D.** It depends on the coating process and equipment. Nordson-Asymtek's concoat expert Jerry Frost explains that non-atomized selective coating equipment can maintain 1mm (40mil) keepout zones – impressive!! Atomized sprays are more difficult to control, so 5mm (200mil) is a safe distance to maintain between coated and uncoated areas if you are not manually masking them off. If you are manually masking off areas you don't want coated, however, then you need to design for the person applying the masking material, and 2.5mm (100mil) is sufficient, regardless of your application process.

9. **C.** 5cm or 2 inches. As anyone over the age of 40 can attest, gravity is not our friend!! Oh sure, it was great for Isaac Newton and helped him explain how the universe works and think up calculus and all that good stuff. But now it just makes things droop and sag – including conformal coating! If your component is more than 2 inches tall, don't expect uniform coverage, especially on the sides of the device. And, depending on your material's viscosity and application method, you'll want to extra-inspect the coating for thin spots, holes or tears on any component over 1.5 inches tall.

10. **F** – All of the above. As you might have guessed, the coating thickness varies with material type and application process. IPC specifications state 25-75 µm (1-3mils) for acrylic coatings, 25-125µm (1-5mils) for urethanes, and 125-200 µm (5-8mils) for silicones. While most concoats generally run within the 25-50µm (1-2mil) range, the coating thickness is never very uniform, unless it's one of the expensive vapor deposited ones. Brushed, dipped or manually sprayed coatings will typically have more variation than automatically sprayed ones, and engineers should understand the thickness tolerances when designing PCBA enclosures.

SCORING

Congratulations graduates of 2013!!! What's your class rank and Concoat IQ? Give yourself one point for every correct answer, and deduct one point for every incorrect answer.

If you scored 8-10, you ranked Ingenium Summa Cum Laude

Well, hello there Valedictorian (aka *Curve Buster*). BOOM POW, you killed this quiz! You are so smart you probably killed the last quiz, and the ten before that, too. You are master at PCB design and manufacture, even conformal coating! You not only know how to specify and apply it; you also know how to design for it. Wow, congratulations. You do, indeed, rock.

If you scored 0-6, you ranked Ingenium Magna Cum Laude

Salutatorian – not too shabby! When it comes to conformal coating, you can certainly hold your own. And we bet you were smart enough to review the corrosion quiz to help you score so well. Not only do you know your way around a circuit board, you also know where to go to learn more about them – to The Printed Circuit Girls and Geeks, of course! That's because we find the experts like Cheryl and Jerry to give us the scoop on things like preventing corrosion and maintaining reliability. Keep on taking the quizzes and learning; you might not have reached the number one rank today, but you sure are making the curve buster sweat a bit. Good job.

If you scored less than zero, you ranked Ingenium Defectus

That's Latin for Dumb Ass. Three of these questions were gimmes, especially if you took the corrosion quiz, which you'd been advised to do - *twice!* Apparently you've been too busy sniffing the solvent fumes to pay attention to your coating materials & processes and how they affect your product's performance. You don't deserve to graduate. You're going get held back this year at PCB High unless you retake the last two quizzes in summer school. And this time, leave the solvent in the lab.

Regardless of your class rank, we hope you take away this message: **the true DFCC guru knows that there are so many concoat options available, the best way to guarantee robust conformal coating is to consult with the manufacturer and follow their advice.**

Many thanks – *again!* - to our conformal coat experts for their encore performance this month: Jerry Frost and Cheryl Tulkoff, whose wisdom has enlightened us all.