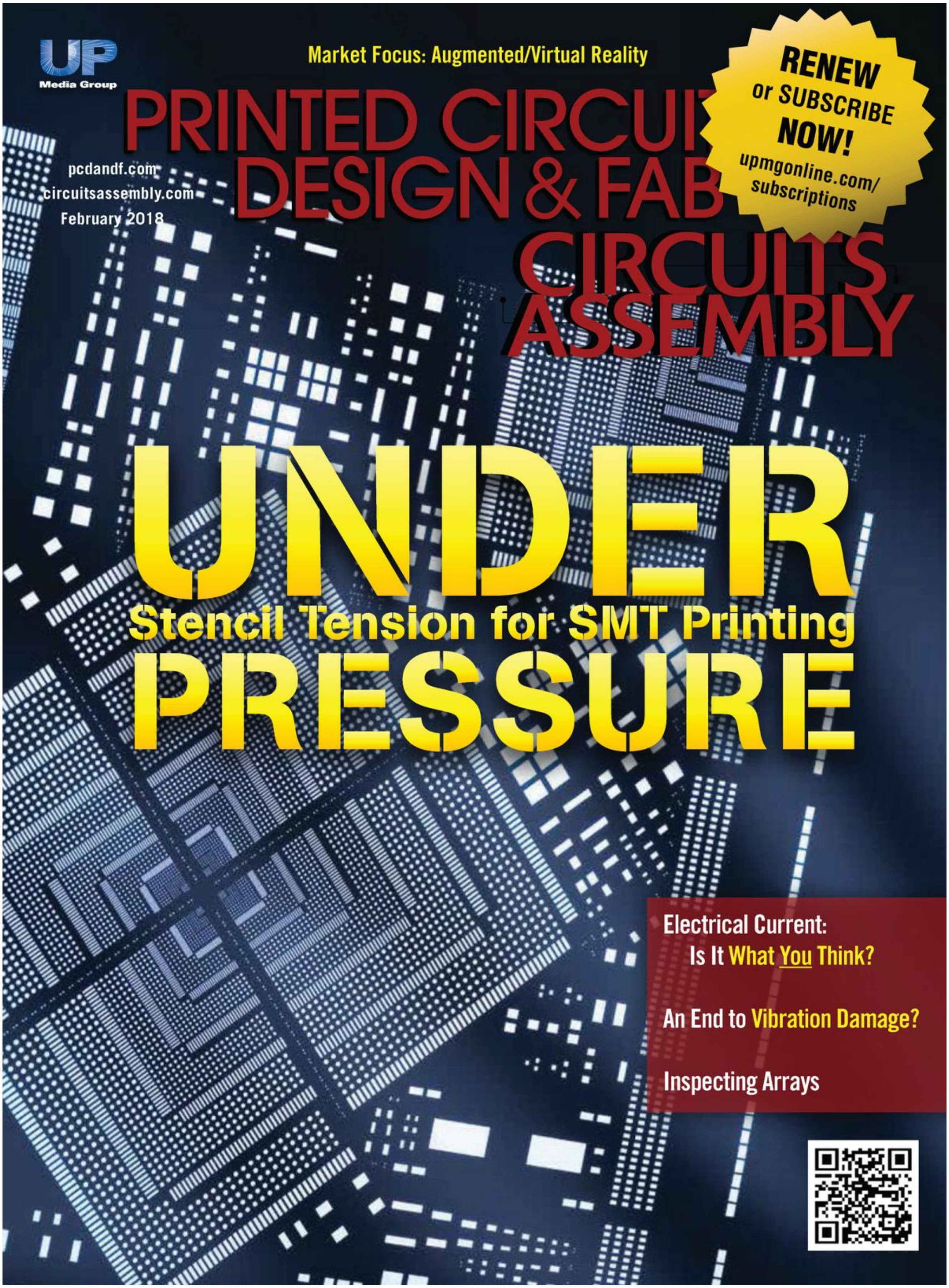
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Over-Molding Plastic over Flex Circuits, Part 2

Picking the material and designing the mold.

THIS IS THE second and final part of the series covering flex circuit over-molding concerns. This month we will discuss mold design, molding materials and molding procedures.

Mold design. While I am not an expert in design of plastic-injection molds, I can share some experiences that will hopefully guide you when creating a mold. First, it is important to keep in mind that flexible circuits become very soft and malleable when heated. Also, keep in mind that motel plastic is *hot!* Now add in the fact that this very hot plastic is moving with high pressure across the flex circuit, which is becoming soft and malleable.

See where this is going? Several years ago, a customer of mine was over-molding a long narrow flex. All the plastic was being injected from one end of the cavity. As the hot plastic moved across the flex, it stretched so that when the plastic reached the far end of the cavity, there was a bunch of extra flex circuit that wasn't supposed to be there. The extra flex length ended up turning into an accordion, which in some instances creased the flex sharply enough to break conductors. The "fix" was to have multiple injection points and position those injection points well in from the circuit end. The circuit would still stretch somewhat during the molding process, but instead of having all the stretch effects end up on one end, they were distributed evenly over the entire length of the flex. The mold will also have to contain locating features to hold the flex suspended in the correct location in the cavity during the injection process. As mentioned in part 1 of this column, it is critical to ensure the flex ends up at or *very close to the neutral bend access of the entire molded assembly.* Even a minimal shift by the flex molded assembly can result in extreme tension compression forces when the assembly is flexed.

Molding material. Picking the proper molding material can be a tricky task. Obviously, the cured plastic in the final product needs to have all the desired physical characteristics (e.g., durometer, biocompatibility, chemical resistance, color, etc.). At the same time, the molten plastic properties (injection tem and viscosity) must be compatible with the flexible circuit so as to not damage the flex during the over-mold process. As a general rule, look for plastics with the lowest possible injection temperature and the lowest molten viscosity. This will cause the least disruption to the flex during the molding process.

It is also important to consider the CTE (coefficient thermal expansion) of both the molding material and the flexible circuit. If there is significant mismatch between the two CTE values, an increase in temperature can cause extreme internal stresses on the flex circuit, which in turn could damage the flex.

Molding procedures. Probably the most important process prior to over-molding is ensuring the flex is thoroughly dry. Flexible circuits are extremely hygroscopic, and anyone who does component assembly on flex knows how critical preconditioning is. If moisture is absorbed in a flex circuit is not baked prior to reflow, the rapid temperature ramp during solder reflow will cause the moisture to expand, causing catastrophic delamination in the circuit. Te same is true with over-molding. When the hot plastic contacts the flex circuit, it will have the same effect as a reflow oven. I recommend using the same prebaking guidelines for over-molding as for SMT. Keep in mind the thicker the circuit is, the longer it will need to bake to completely drive out all moisture.

Analysis and testing. In most over-molded flex circuit assemblies, it will be nearly impossible to inspect the flex for damage after it is molded in place. The only way to inspect the final product is a destructive cross-section to look for delamination, conductor cracks, etc. But in order for a cross-section to provide meaningful results, you need to know where to perform it. Unil there's a failure, this won't be known. In some cases, if the plastic is soft enough, you may be able to surgically remove the flex for inspection. I would recommend sacrificing a few assemblies after over-molding for cross-sectional analysis (in multiple axes) and also for possible removal of flex for inspection. In the long run, the most important aspect is the reliability of the final product. There is no good replacement for mechanical functional testing. Set up a flexing tester that mimics the bending the product will be subjected to. Cycle several pieces through what would be representative of the product life, and also cycle some to failure to see how the two values compare. As mentioned in part 1, this can be a challenging endeavor and may take a couple of tries to get the over-molding process perfected for a given application. PCD&F

Ed.: See part 1 in the December 2017 issue

MARK FINSTAD is senior application engineer at flexible Circuit Technologies (flexiblecircuit.com) mark.finstad @flexiblecircuit.com. He and co-"flexperts" NickKoop (nick.koop@ttmtech.com) welcome your suggestions.