Ninja Flex Circuits

Tom Woznicki - Flex Circuit Design Company

One thing that I've always liked about flex circuits is that they look cool! Shiny, orange and clear so you can see those beautiful curved copper traces unlike their green rigid-board counterparts.

But if you've looked inside a smartphone or seen a teardown article on an iPhone you don't see beautiful shiny flex circuits - you see flex circuits that look like they were spray painted with black primer.

Do not be deceived by their drab appearance - these are Ninja flex circuits! They have special coverfilms that give them powers to suppress EMI, eliminate glare, control impedance, reduce cost. They also disguise and protect intellectual property - it takes a great deal of effort to reverse engineer them and you literally destroy the circuit in the process.

Figure 1 - iPhone 5s teardown by iFixit.
Used with permission.

Figure 1 shows an iPhone 5s teardown by iFixit. Figure 2 is a close up view of the camera module - you can see many different flex circuits all covered by either black coverfilm or shielding film.

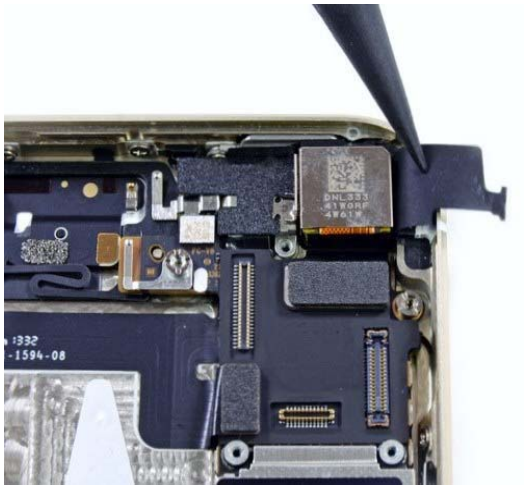

Figure 2 - Closeup of camera module.
Used with perimission of iFixit.

Black coverfilms are exactly as the name implies - coverfilm made with black polyimide. It is widely used on flex circuits for LEDs and cameras. Just punch openings and laminate it to the base laminate like normal coverfilm. DuPont offers Pyralux® LF-B and halogen-free Pyralux® HXC. Korean companies Innox and Doosan

also make black coverfilm. Other companies, such as CEN in China, offer black polyimide which can be used with freefilm adhesive to create coverfilm.

There is a subset of black coverfilms that are used to protect components from static - the polyimide is electrically conductive but with a very high resistance. These materials are not readily available off the shelf as coverfilm - they would be applied using freefilm adhesive or by having a custom materials company make coverfilm from the polyimide sheets. DuPont has Kapton® XC and CEN's antistatic polyimide is called BY.

Shielding films have a very thin metal coating (around 0.1 micron) and an electrically conductive anisotropic (conducts in z axis) adhesive. They provide an extra layer of shielding without the expense and thickness of an extra copper layer. Some are black and some are silver. They are applied after coverfilm lamination and require coverfilm openings that expose copper that is connected to ground.

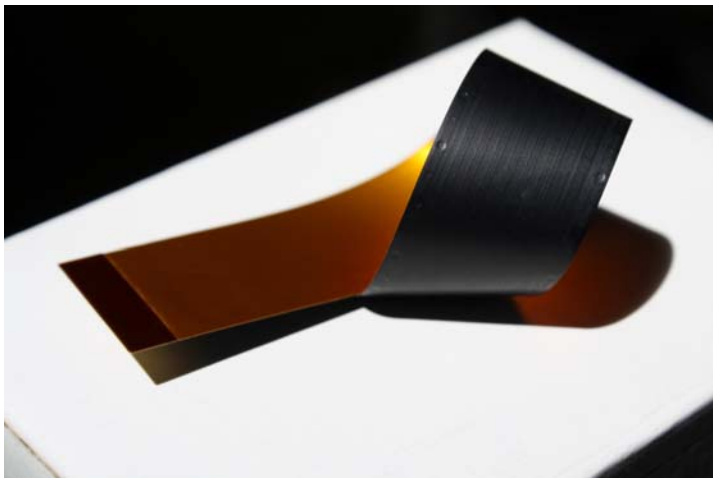

Figure 3 - ZIF flex circuit with two copper layers and shielding film.

I recently designed a flex with shielding film - a simple ZIF jumper (figure 3). The circuit has two copper layers - signal and ground plane. Customer wanted complete shielding, so rather than adding another copper layer we specified shielding film. Along each edge of the flex is a wide copper trace tied with vias to the ground plane below. Round coverfilm openings exposed these traces so the anisotropic conductive film could make the electrical connection. In figure 4 you can see the depressions

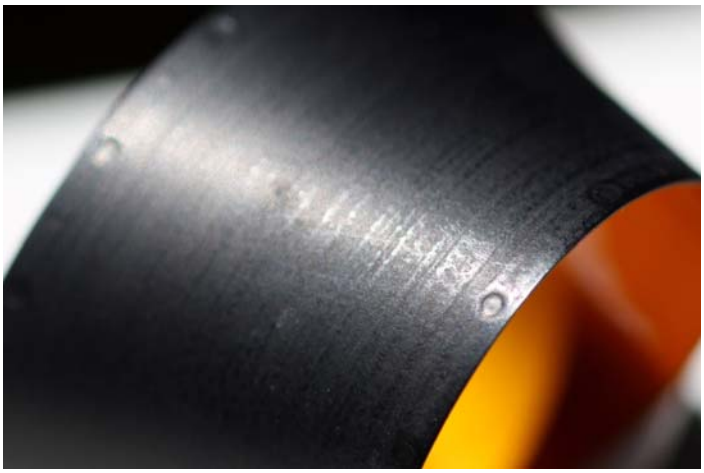

Figure 4- Depressions showing where coverfilm openings allow electrical connection to the shielding film.

where the lamination process pushed the shielding film down into the round coverfilm openings. This particular shielding film is only 8 microns thick so it really conforms to the surface of the flex. Figure 4 also demonstrates how the shielding film completely hides the trace layout.

It's possible to create a fully shielded flex with only one copper layer using shielding film. Just apply an oversized piece of shielding film to both sides of a single-layer flex after the circuit is cut from the panel. The shielding films will bond to one another in the area past the flex circuit outline. Trim back the bonded shielding film close to the flex outline and you have shielding all the way around!

A nearsighted flex ninja with ninja flex circuits.

There are many companies making shielding film - Tatsuta, Toyo Ink, Doosan and Innox are major suppliers.

So if your flex application has some special requirements look to black coverfilm, antistatic coverfilm or shielding film to give it some ninja powers!

Big thanks to iFixit for permission to use the iPhone 5s teardown pix and to Robert Jung at Altaflex for his help with sourcing info.

DuPont - www.dupont.com
CEN - www.cen-polyimide.com
Innox - www.innoxcorp.com
Doosan - www.doosan.com
iFixit - www.ifixit.com/Teardown/iPhone+5s+Teardown/17383
Altaflex - www.altaflex.com

Tom Woznicki is the president of Flex Circuit Design Company., a consulting company in San Jose, CA. Flex Circuit Design Co. specializes in designing flexible printed circuits for OEMs and flex circuit manufacturers. For more info go to www.flexdude.com.