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IMAGING:

ADAPTING TO THE CHANGING TECHNOLOGY

Different Copper Foils for Different Reasons

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SUMMARY — Various copper foils have their own unique sets of capabilities and limitations. Understanding these attributes can be very important for the circuit fabricator as well as the OEM.

Introduction

The many different classes of copper foils used in the PCB industry have their own capabilities and limitations. When you get into the details, copper foil issues for PCB applications can be overwhelming. In a broad sense, there are two types of copper foil used: rolled copper and electro-deposited (ED) copper. Within these two types there are a tremendous amount of variants. To add to the complexity, several different treatments may be applied to these coppers, and for a variety of reasons.

Rolled Copper

In general, rolled copper has been used extensively in the flexible PCB industry for decades. The grain structure and smooth surface is ideal for dynamic, flexible circuitry applications. Another area of interest with rolled copper types exists in the high-frequency PCB industry. It has been proven that copper surface roughness can impact high-frequency insertion loss and a smoother copper surface is advantageous. As with all material issues there are always pros and cons, and with the benefit of rolled copper being smooth, it is sometimes offset with the fact that less mechanical tooth can cause challenges for bond strength.

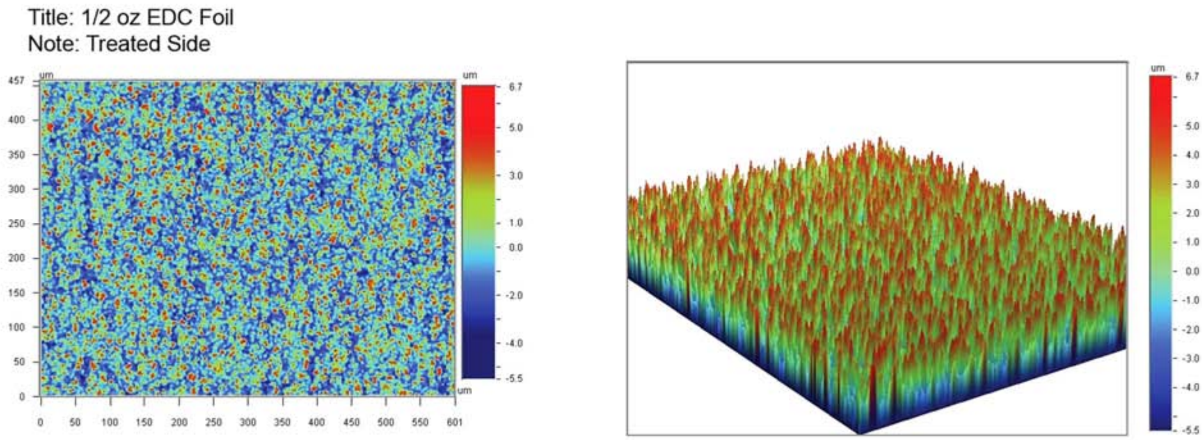
Additionally, rolled copper can be related to the horizontal grain structure, which can be more challenging for the etching of tight conductor spaces. Beside the grain structure, there can be imaging issues with lower adhesion of the photoresist to the smooth rolled copper surface. Having a poorer bond of the photoresist to the smooth copper surface can be a disadvantage for imaging and developing dense circuit patterns.

Electrodeposited Copper

With respect to ED copper, there is a huge diversity of foils regarding surface roughness, treatments, grain structure, etc. As a general statement, ED copper has a vertical grain structure that can be advantageous for obtaining tight-etched spacing and well defined conductor walls. The standard ED copper typically has a relatively high profile or rough surface as compared to rolled copper, and can benefit bond strength.

Classifications within ED Copper

There are different classes of ED copper. As a basic classification, they are: high-profile, standard profile, low-profile and very low-profile. The high-profile coppers are often used in applications where high bond strength is required. Some issues associated with high reliability benefit from the high-profile copper foils as well. On the other end of the spectrum is the very low-profile coppers, which are often used to minimize electrical conductor losses associated with insertion loss for high-frequency applications. During the past several years there have been many of these very low-profile copper foils offered with reverse treat, where the bond enhancement layer is on the outside of the copper



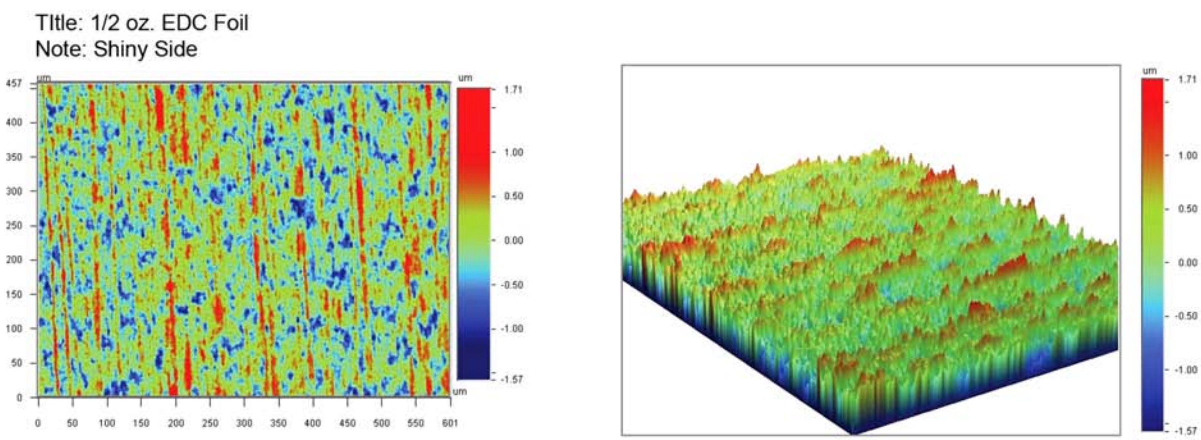
Copper Attribute

Rq	1.86 um

Measurement Information

Filtering	Low Pass
Filtering	Low Pass
Magnification	10.28
Measurement Mode	VSI
Pixel size	817.12 nm
pixel	736 X 480

Figure 1: Mapping of the copper surface of a high-profile copper when scanning the treated side.



Copper Attribute

Rq	406.09 nm

Measurement Information

Filtering	Low Pass
Filtering	Low Pass
Magnification	10.28
Measurement Mode	VSI
Pixel size	817.12 nm
pixel	736 X 480

Figure 2: Mapping of the same copper, but scanning the shiny side of the copper, which is the side the circuit fabricator will have exposed to them.

of a laminate. This enables the circuit fabricator to have access to the treatment layer of the copper and also offers significant benefits with photoresist adhesion. Having a good copper treatment surface for the adhesion of photoresist enables better capabilities for imaging and developing of dense circuit features.

There is an art to measuring copper surface roughness and many different test methodologies exist. Additionally, several different characteristics of the copper profile may be reported. Most often the R_a or the R_z numbers are reported by the copper foil suppliers. The R_a values are basically the average peak-to-valley numbers within the measurement scan area. The R_z number is similar to the R_a, where it is the average of the peak-to-valley numbers in the scan area, except this value is from five consecutive points measured. The measurement that is regarded as the most appropriate in regard to high-frequency electrical performance is the R_q value. This is also considered the root mean square (RMS) of the peak-to-valley measurement within the scan region.

Historically, the copper-surface roughness has been measured with a physical stylus procedure. This is a well known test method, but it may report a smoother profile, due to the limitation of the stylus tip in reaching the depth of a valley. There are also laser profilometer measurement methods that are generally regarded as more accurate; however, there are several different technologies and techniques to consider. An example of a laser profilometer measurement is shown in Figures 1 and 2.

Conclusion

There are many different types of copper foils, each with its own set of capabilities and limitations. Understanding these attributes can be very important for the circuit fabricator as well as the OEM. As always, it is highly recommended that you contact your materials supplier when considering different materials—especially copper foils. **PCB**

John Coonrod is a market development engineer for Rogers Corporation, Advanced Circuit Materials Division. About half of his 25 years of professional experience has been spent in the flexible PCB industry doing circuit design, applications, processing and materials engineering. Coonrod has also supported the high-frequency, rigid PCB materials made by Rogers for the past 10 years. Reach Coonrod at john.coonrod@rogerscorporation.com.