Today’s search for smaller grain size includes silver, and nano silver electroplating is currently being researched. This article will include photographic examples that show the grain structure of the E-Brite 50/50 alkaline non-cyanide silver process, including instances when the bath has not been filtered sufficiently. The filtering of the E-Brite 50/50 process is important to achieve finer grain size.

Also included in this article will be a discussion on other physical characteristics of the E-Brite 50/50 process. The E-Brite 50/50 process is a production-proven method that is both stable and reliable (see testimonial on next page). Recently, a new development of plating on nickel substrates other than electroless nickel (EN) has been achieved through utilizing an electrolyte prep.

**BATH SETUP AND SPECIFICATIONS**

The bath is an alkaline, cyanide-free liquid solution that contains silver ions, electrolytes, and DI water. The mixed bath is a clear solution. The pH is adjusted using potassium hydroxide (KOH) and sulfuric acid. It is essential to maintain pH between 8.5 and 9.2. If the pH is too low, you will get the immersion deposition of silver, and it will be necessary to add 45% KOH to raise the pH to around 8.8. Also, do not let the pH of the bath exceed 10.5.

Note that the silver metal concentration in both the rack and barrel formulations are about 50–60% of the concentration found in most cyanide baths. Thus the silver drag-out losses are greatly reduced with this non-cyanide bath compared with cyanide baths.

**PLATING BATH OPERATION**

**Plating rate:** After the initial make-up, the silver bath must be filtered continuously using a 5-µm or smaller spun-polypro cartridge and carbon filter. The optimum cathode current density for this non-cyanide silver bath is 3–10 ASF. The cathode efficiency is around 95%. Table 2 lists the plating rate for various current densities.

**MAINTENANCE**

Bath maintenance typically comprises regular addition of a silver complexor/stabilizer, pH adjustment, and continuous conventional and carbon filtration. Silver is supplied by the slab silver anode. This method is cost effective because it plates out of the silver anodes rather than the solution. Rarely the silver metal will drop too low and silver concentrate must be added.

A silver-stabilizing electrolyte is added on a regular basis to complex the silver dissolved from the anodes. Additions of silver stabilizer are made based on ampere hours and hull cell tests. Additions are usually required every 500 ampere hours and the required addition will be based on the silver concentration. Typically a 1–2% daily addition of this electrolyte will be required while plating. If the solution sits idle for a week or longer, a 2% by volume addition of the electrolyte should be made.

The silver stabilizer and its breakdown products can also be analyzed by high-performance liquid chromatography. Years of industrial practice with this non-cyanide silver...
lent. The bath does not immersion coat on copper, and excellent adhesion can be achieved without the need for a strike bath.

With the introduction of pulse-plating technology, it may be possible to achieve nano-sized deposit structures using this non-cyanide silver process. The crystalline structure of the silver coating is also characterized by X-ray diffraction. The broader diffraction peak of the non-cyanide deposit suggests a finer grain than that of a cyanide silver deposit.

**Hardness:** The hardness of non-cyanide silver coating is around 95–110 KHN, which is slightly harder than the cyanide silver from a solution with no additives. The hardness is measured on a cross-sectional sample with a Knoop diamond indenter at a load of 25g.

**Electrical resistance:** The electrical resistivity of the non-cyanide deposit is around 3.0–3.5 µΩ/cm, which is slightly higher than that of the cyanide silver deposit, and is suitable for electrical applications.

**Wear resistance:** The wear resistivity of the non-cyanide silver deposits is superior to that of cyanide silver deposits. The wear test, performed by Taber Abrader, abrades the silver deposit with a load of 250g.

**Purity:** The purity of the non-cyanide silver deposit is around 99.8%, which is characterized by Auger emission spectroscopy. E-Brite 50/50 alkaline non-cyanide silver has always plated directly to mid-phos EN substrates with excellent adhesion. The reason for the adhesion of the silver onto the mid-phos EN process is the nickel plating structure is amorphous while electroplated nickel is laminar. Recently, plated nickel substrates such as Woods, Watts, and sulfamate nickel can be plated without a separate nickel strike. Following is a description of the process:

1. E-Prep 242: 60 g/l 8 oz/gallon, 130–150°F, 4–8 V, cathodic current 15–40 ASF, 40–50 seconds
2. Cold-water rinse
3. 5–20% by volume sulfuric acid
4. Cold-water rinse
5. Plate with E-Brite 50/50, entering plating solution live

**PHYSICAL PROPERTIES OF NON-CYANIDE SILVER DEPOSITS**

**Appearance:** Parts have a slightly dull appearance, which is quickly converted to a bright white by dipping them momentarily in dilute sulfuric acid. The throwing is excellent.

**Process shows that the breakdown products has no ill-effect on the physical properties of silver deposits. Continuous conventional and carbon filtration with 5-µm or finer filters is critical for the successful operation of the non-cyanide silver process. Silver non-cyanide compounds are normally less stable than the cyanide silver. Therefore, silver peroxide (AgO) particles can form when silver stabilizer is not present in sufficient quantities. The SEM morphology of a normally operating silver deposit is shown in Figure 1. The deposit is smooth and has a fine grain structure. If the silver bath has not been filtered and has idled for awhile, the silver deposit tends to lead to bigger grain structure and the deposit can be more “rough,” which is shown in Figure 2.

**TESTIMONIAL**

Joe Miller, Plant Manager, Helwig Carbon Corp.: “EPI’s non-cyanide silver plating bath replaced our existing cyanide silver plating bath. We made the switch due to [the] high cost associated with Homeland Security compliance. I estimate we saved $19,030!!! Besides the obvious fact [that] we have a safer work environment, other benefits include lower operating cost and further reduced costs associated with environmental compliance. EPI’s Bob Campbell and Sid Arthur provided excellent customer service and technical support to assure a smooth transition. I was impressed with on-site support to get us up and running! Both gentlemen spent ample time on operator training and continue to be readily available if necessary. The first day up, we were able to test a wide variety of our product line. All results
CONCLUSIONS
The E-Brite 50/50 process can plate a finer grain deposit than cyanide silver when using the correct filtration. This allows plating directly onto nickel substrates using an electrolytic prep, while allowing many other benefits to accrue for the silver electroplater. There is a new drive to eliminate cyanide if you list the substance in your Department of Homeland Security (DHS) report. The E-Brite 50/50 process eliminates the cyanide, saving time and the cost of DHS reporting, resulting in a new tangible benefit.

BIO
Eric Olander is the president of Electrochemical Products, Inc. (EPI), a New Berlin, Wis.-based manufacturer of ISO-9000-certified chemicals for the metal plating and finishing industry. Olander also holds the position of chairman of the 2009 SUR/FIN Steering Committee. He may be reached via e-mail at erico@epi.com.

ACKNOWLEDGEMENTS
Images for this article were supplied by the Université de Sherbrooke.