Introduction

JDSU’s Flex Products Group, now part of JDSU OSP, has a long history with optically variable pigments used in security and made using roll to roll vacuum coating. JDSU is the leading manufacturer for security pigments used on bank notes other secure documents. JDSU materials, color shifting pigment, are used by more than 90 countries on bank notes. JDSU has recently launched several products that build on this legacy.

Initially the color shifting pigment was seen and developed as a simple way to prevent color copies/scans of bank notes. Tight control of material and technology resulted in a much larger anti-counterfeit role for the product. Even sophisticated counterfeiters have trouble emulating the material without access to the pigment/ink.

The two new products addressed in this paper do rely on roll to roll vacuum coating as a core capability. However, each product has its own new and unique additional capability requirements that add substantially to the product performance and anti-counterfeit strength.

The focus is on the technology behind two products that are combinations of vacuum coating with a new enabling technology.

Starting point is the traditional JDSU OSP strengths: vacuum coating and pigment conversion. The added capabilities and skills are what make JDSU a stronger player in this market.

Example of the type of coating equipment that is used for color shifting pigment
Due to the nature of the products disclosures in this document are of limited depth and detail. This paper is to be seen as a case description of roll to roll coating processes combined with quite different technology as a way to create new valuable products.

Anti-counterfeit products

Anti-counterfeit products face a number of specific challenges. Access to security products and technology needs to be tightly controlled; even a very small leak can cause very substantial damage.

Vacuum coating in general is a commoditized production process. All production processes without a need for highly proprietary skills/knowledge tend to move to lower wage countries. The model for the category of products is based on this NOT happening, which means that the intellectual property and proprietary component requires ongoing renewal.

The average banknote contains pennies worth of security, a counterfeiter can easily spend >1000x that per unit and still make the financial math work.

To make this even harder, the training and skill level of the average end user of banknotes is extremely low in many countries. Populations with higher counterfeit levels do tend to score better in this. In many person to person financial transactions there is a level of awkwardness in scrutinizing a banknote

Design cycles for banknotes are long. First instances are usually small volume commemorative notes. 7 to10 years from product introduction to first volume production is considered fast.

Color shifting pigments with a level of performance that allows low grade counterfeits are now somewhat more widely available. The anti-scan and photocopy function still works, customers now do expect far more functionality from this product category.

Durability requirements for banknotes are hard to meet. Security features in essence need to survive all other functional properties of a banknote

Vacuum coating is inefficient with materials. The average is 10 to15 % utilization. Some materials can be reclaimed but for many it acts as a substantial multiplier in the per kg cost of the component for pigment. Vacuum coating is also inefficient with energy. It requires material phase changes with energy flowing in one direction only and pumps that achieve and maintain a high vacuum.

Pigment is measured in kilos per day; roll coating is measured in nanometers per second /s or Angstroms per second or grams per square meter. The units used do show the complete disconnect. Getting to kilos with coated material is a major effort by itself.
Security products by definition have to be very hard to manufacture, even in low volumes. Counterfeiters do not need high product volumes, counterfeit large denomination notes do add up fast. Regular product engineering for ease of production is not an option. The opposite is an odd proposition and yet something that applies.

Next generation Optically Variable Pigment

The requirement was to develop a new overt feature that is low cost easy to apply, low cost and easy to authenticate for untrained users.

The new product needs to build on the color shifting pigment infrastructure (user training and production equipment) and add a substantial level of additional protection and performance. Printing remains a preferred application method

The color of the color shifting flakes is determined by the viewing angle. Controlling the angle at which pigment flakes are position in the ink layer to enables new visual effects.

Example of a print with magnetic color shifting pigment

The solution was found in the form of a newly developed Magnetic Optically Variable Pigment. This pigment includes a ferromagnetic magnetic layer in the core of the color shifting layer structure. It is printed using newly designed sophisticated magnetic systems that mount on a printing press and result in appropriate magnetic field shapes. The systems generate a magnetic field that aligns the pigment flakes before
the ink is cured.

The prints with this technology are visually more interesting and attractive. Attention drawn from the user by the feature does help with the effectiveness of an authentication feature. Aligning the pigment flakes highly improves the chromaticity of the printed ink, pigment flakes are grouped with identical reflection angles.

The new feature cannot simply be emulated using traditional color shifting pigments.

Integration of a ferromagnetic metal layer in color shifting pigment is not a straightforward procedure.

Highly sophisticated and complex magnet systems can result in more elaborate Fresnel structures that carry extra anti-counterfeit strength.

New covert taggant

The requirement was to design a covert security feature that is low cost, easy to apply and easy to fully authenticate for people with limited training and simple tools.

The constraints were that it had to be different per customer so one leak does not potentially impact all other users. Printing is the preferred application method. Tools to identify/copy the use of exotic materials should be commonly available.

The solution was found in a shaped pigment with graphic a microscopic scale, read with a handheld microscope.

The product is made by originating micrometer sized graphics and frames with laser and/or E-beam technology. The origination resolution is beyond the wavelength of visible light. The smaller details do not show with low end microscopes or visible light and provide an extra forensic level.

This origination is recombined and replicated on PET substrate that is vacuum coated and processed like for other vacuum coated pigments. The various layers are made with boat evaporated Aluminum and thermally evaporated Zinc Sulphide or Silicon Oxide.

The taggant material is sprinkled in with other pigments or applied by itself in clear inks.

Verification of presence, authentication is done by a handheld 200 to 400 x metallurgical microscope.

The taggant flakes are small and sturdy enough for use in Flexographic, Gravure, Screen, Intaglio and even Offset printing. The product found its way to Billions of units/year for brand protection, ID documents and value documents. The ability to
locate and to read a verbose text or graphics on a micro flake eliminates uncertainty, even for unskilled users.

The average time to train a user for verification with handheld microscope is less than a few minutes. Pushing a button and reading a status display would leave far more questions to be answered on false positives, false negatives and reader technology. Keeping it simple proves effective.

The main limitation of the product as a covert is that it does not allow high speed machine reading, this aspect was part of the original set of product requirements.

**Conclusion**

Commoditization like in other markets does not work in the security products market, it defeats the product purpose. Vacuum coating and pigment conversion alone is longer term not enough to sustain a unique and strong industry position in the anti-counterfeit product market. New products may well use further enhanced vacuum coating methods but will preferably and likely comprise substantial other technology components as well.

Darwin wrote ‘survival of fittest’ not ‘survival of the strongest’. JDSU is very strong in anti-counterfeit products. It is fitness that determines sustenance of this strength. Fitness in this context, and in the context of nature, is largely determined by the ability to effectively change and re-invent whenever the circumstances require this. This likely applies to many AIMCAL members.

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