Transforming Colour-Shift Materials into Tunable Colour-Shift Pigments

Opalux – based in Toronto, Canada – presented one of its latest innovations, namely the transformation of tunable colour-shift materials into tunable colour-shift pigments for integration into banknotes and identity documents, at this year's *Optical Document Security*™ conference in San Francisco, US.

Opalux's photonics colour technology is based on materials having a repeating structure, that are either ordered arrays of holes or alternating flat sheets. These materials have the properties to reflect specific wavelengths of light or particular colours based on the spacing between the repeating units.

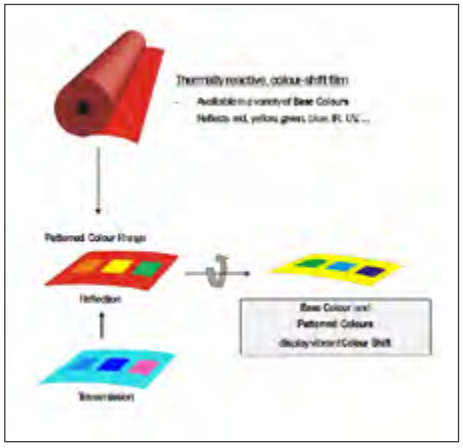
However, what makes photonic colour unique is that these structures incorporate stimulus responses which allow the structures to change in dimension when exposed to certain stimuli, such as thermal, mechanical pressure, electrical current and chemical. For example, if application of a stimulus causes the spacing of the material to contract, then this shifts the reflected colours to shorter wavelengths – in this case from green to blue. If, conversely, the application of a stimulus causes an increase in the spacing, the reflected colour is shifted to longer wavelengths – in this case from green to red.

Two of Opalux's products that utilise its photonic colour platform are *OpalPrint* and *Prismalux,* which are described below.

OpalPrint

OpalPrint is a patternable, multicolour colour-shift film that is also the foundation for the tunable Prismalux pigment.

It is produced as a roll of thermally reactive colour-shift material that is available in a range of base colours including red, yellow, green, blue and also invisible states such as infra-red (IR) and ultra-violet (UV). When the film is exposed to heat from either laser engraving or hot embossing, the colour is shifted based on the amount of heat input. In this way, a patterned colour range is generated.



An example of OpalPrint multicolour colour shift film.

In the above example, a red colour is shifted to orange and then yellow and then green with increasing heat input. The base colour – as well as each of the patterned colours – displays their own unique and vibrant colour-shift. Furthermore, OpalPrint also has a high degree of optical transparency. This enables the visualisation of complementary transmission colours on a clear window or when placed on a white background.

The process of patterning the film using either heat or lasers can be carried out locally or pixel by pixel to create localised colour changes. As more heat is applied, the colour will continue to shift until it reaches its end point state where the material can no longer contract: at this point further heat input will have no effect. This feature is particularly useful for processes where there are temperature variations, thereby ensuring the consistent patterns and colours are achieved.

Colour shift versus multi-colour colour-shift?

A single colour colour-shift material will have a particular colour when viewed at an angle from a light source. As the material moves with respect to the light source and the observer, the perceived colour of the material will change, for example from red to yellow.

A multicolour shift material, on the other hand, will reflect multiple distinct colours at a given angle. As this material is moved with respect to the light source, each distinct colour will show its own colour shift. This is a key feature of OpalPrint and Prismalux, allowing increased security and design flexibility.

Applications of OpalPrint

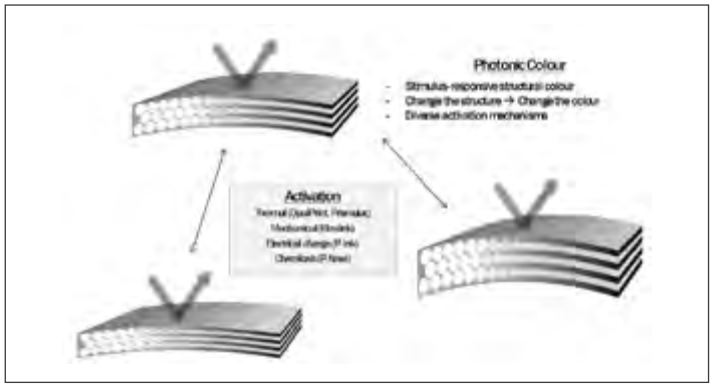
By virtue of its unique optical and tunable characteristics, OpalPrint can be used for several types of features for high security documents, such as banknotes, passports, ID documents and polycarbonate (PC) cards.

For banknotes, OpalPrint can generate full colour-shift stripes or threads with perfect registration. Each colour displays its own unique colour-shift that is active in both reflection and transmission, enabling complementary colour sets to be observed.

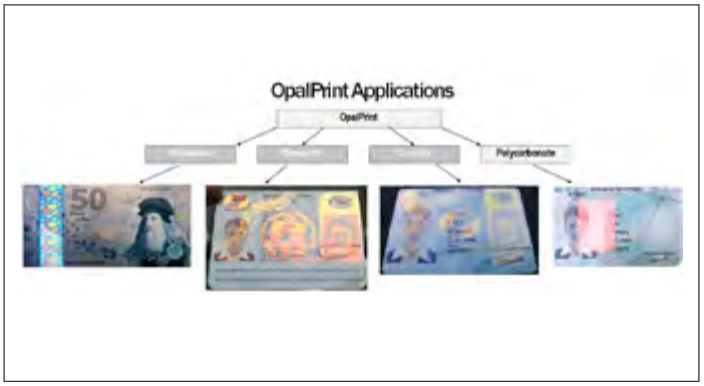
For passports, OpalPrint laminate can be individually patterned with personalised features such as a portrait, signature and a document number. Furthermore, as OpalPrint is transparent, it allows the information on the passport data page to be viewed unimpeded.

Similarly to passports, OpalPrint can also be used for ID cards as a surface feature on polycarbonate, PVC or Teslin. A variant of OpalPrint, *OpalPrint Polycarbonate,* has also been developed to be embedded in a polycarbonate identity document (see AN July 2016).

This is a multi-coloured colour-shift feature that can be personalised with the same laser as the rest of the polycarbonate document, thereby defeating common portrait alteration techniques. OpalPrint can therefore be described as enabling personalised security.



Opalux photonics colour technology.



OpalPrint applications for banknotes, passports, ID cards and polycarbonate.

Developing Prismalux

OpalPrint film is used to create functional tunable pigment particles (Prismalux), which are suitable for high security printing inks.

Development of the Prismalux pigment begins with proprietary polymers and additives that are the foundations of the pigments optical and tunable properties. These components are formulated into a coating and subjected to a precision roll-to-roll coating process onto a carrier film, thereby creating rolls of Prismalux pre-cursor film.

This film has optical and tuning properties very similar to OpalPrint. However, one notable difference is the inclusion of specific release layers that enables the release of the Prismalux from the carrier film/web. The entire coating is released from the carrier film and then subjected to a controlled grinding process, creating Prismalux pigment.

Prismalux precursor film.

However, although the pigment grinding process initially appears to be a simple process, there are many ways for the pigment production to go wrong, for instance:

- The Prismalux release and grinding process may generate particles that are too small, resulting in the edges of these particles scattering incoherent white light and drowning out the colour-shift effect. Furthermore, when the pigment particles are too small, they cannot properly align, which results in a loss in the reflective properties.
- Delamination can occur under certain release and grinding conditions. The Prismalux material can suffer 'inter-coat splitting' (ie. the coatings come apart within the multi-layered structure instead of lateral delamination from the carrier film, resulting in a destroyed optical effect).
- Another way performance can be compromised is through the thermally active component being compromised. In this case, the initial optical effect may be maintained in addition to the colour-shift. However, if the active component is compromised, the pigment may not respond to heat input.

Despite the above initial pitfalls, optimised process conditions have now been established, ensuring the right flake shaped pigment particles are generated with an optimised size range of less than 30 microns, and a thickness of 2 microns. This makes them suitable for screen printing applications. The optimised pigment particles have an elongated aspect ratio, allowing pigment alignment whilst minimising incoherent scattering, thereby maximising the optical effect.

The Prismalux pigments are available in a multitude of base colours and colour-shift options and are compatible with standard water based ink formulations and common co-solvents such as alcohols or glycol ethers. Opalux have developed an aqueous proprietary coating using this material.

ID personalised security

As is the case for OpalPrint, Prismalux can be used for several types of features for high security documents such as for personalised security of ID (passports and ID cards) and also for banknotes.

Using passports as an example, the generation of the Prismalux feature begins with the process of printing or coating a Prismalux patch or region on a passport data page.

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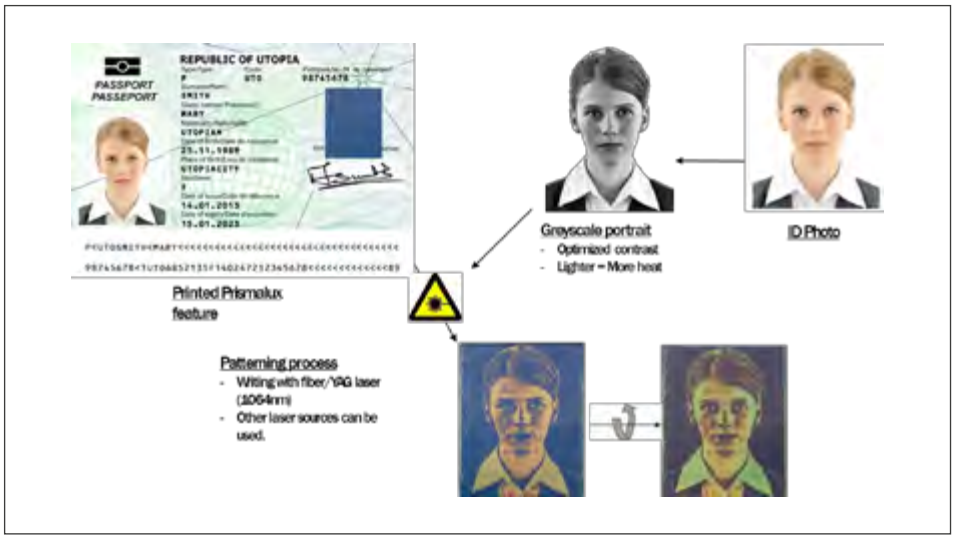


An example of the Prismalux portrait process for a passport data page.

Authentix Launches Sherlox

Global authentication and information services company Authentix Inc – headquartered in Texas, US, has launched *Sherlox*™ – an end-to-end authentication offering for brand owners that includes an integrated system of security markers, readers and data information system.

Sherlox is built to be mobile and can be used with a smartphone, tablet, or computer. This latest development enables brand owners and investigators to quickly identify counterfeiting hot spots and trends in counterfeiting activity of their products around the globe. Authentication is instantaneous as Sherlox utilises the Authentix *AXIS*® information system that allows field data and location information to be stored and analysed.

'Sherlox will assist brand owners and investigators in locating the sources of counterfeiting activity in their global supply chains as well as simplify the case management process,' says David Schneider, Vice President and General Manager, Authentix Brand Business. 'Authentix has taken the Internet of Things framework and applied it to brand protection, creating a dynamic global view for brand owners to assess their supply chains and distribution channels and take action.'

Sherlox also includes services to advise brand owners on the design of a brand protection programme, provide implementation services (including training and certifying printers and contract manufacturers) and operations support to ensure the success of the authentication programme.

www.authentix.com

Transforming Colour-Shift Materials *(Continued)*

The next step is to take the bearer's standard ID photograph and convert this photograph to a grayscale portrait to be used for laser writing. In the example portrait, the lighter regions will generate higher laser intensity and therefore a higher heat and a greater shift in pattern colour, which is similar to the properties of OpalPrint.

The Prismalux feature is then patterned with an industry standard fiber laser source at 1064nm using the greyscale image. Other laser sources such as carbon dioxide, green lasers and others may be also used by selecting the appropriate laser sensitiser. If these conditions are correct, a Prismalux portrait of the bearer, and if required ID numbers, can be generated that show colour-shift on tilting.

According to Opalux, Prismalux is able to provide personalised security, fusing the security of colour-shift with the unique personalised information of the document holder into a single feature.

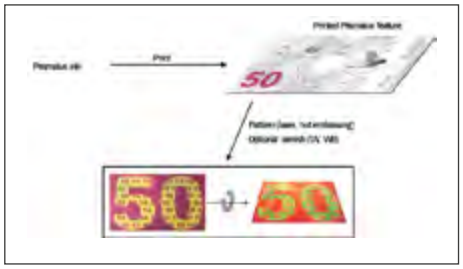
In addition Prismalux can also be used to generate multicolour colour-shift features for banknotes.

Banknote security

For banknotes the creation of a Prismalux feature begins with the formulation of a Prismalux ink and then printing of the ink onto the surface of the banknote. The initial feature exhibits single colour colour-shifting properties prior to being subjected to heat, either through a laser writing process or via hot embossing.

The feature can also be optionally coated with a UV or water based varnish for enhanced durability. During the heating process, a secondary multi-coloured image with colour-shift properties is created within the initially single coloured printed feature.

An example of a Prismalux patch on a banknote is shown below, exhibiting a patterned array of small 50's within the large 50's. All the colours show distinct colour shift properties.



An example of a Prismalux patch on a banknote.

Prismalux stripes can also be printed on banknotes. On tilting the note the stripe changes from deep red colours to orange and the gold shifts to green (see below).

An example of a Prismalux stripe on a polymer banknote.

Opalux is looking for partners interested in developing Prismalux inks, and in further validating Prismalux for their security applications.

www.opalux.com

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