

# The Evolution of Card Substrates

An ITW Security Division White Paper – September 2016



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## Overview

For many years PVC was seen as the single substrate for the ID Card market, whether for Secure ID's (National ID, Driving License, Healthcare Cards or Voting Cards) or Non-Secure ID's (Corporate Cards or Membership Cards). PVC has many advantages for use in the ID card market – it is a relatively cheap and accessible substrate yet through excellent adhesion properties can still be securely protected with high security products such as holographic patch laminates and unique laminate protection offerings such as ITW Security Division's recently launched HoloPrint patch. PVC is directly printable with D2T2 colour imaging and can also provide an excellent substrate for addition of personalized security features, such as those available from ITW Security Division's ribbon products. However, whilst PVC has proven to be a very versatile substrate for card production over the years it is no longer regarded as the most secure. PVC Cards can be sourced online from almost anywhere these days and can be personalised using readily available desktop printers. This makes them great for fast, convenient and low cost ID creation. *But it also makes them extremely susceptible to fraud.*

As well as questions regarding its security and availability, PVC is also not the most durable card substrate available. When PVC first entered the market space as an ID Card substrate, Payment Cards tended to have a life span of 2-3 years and Driving Licenses between 4 and 5 years. As the requirements for such cards have expanded to include the embedding of Smart Card technologies for example, cards issuers are now requiring much more durable materials to ensure that their cards last longer and can justify the increased cost of the additional elements.

It is not just increased security and durability that are now required by customers, environmental issues have also become increasingly important. Manufacturing PVC creates a lot of environmental waste, which is a challenge for card issuers who need to minimise their environmental impact.

So if PVC is no longer the primary choice for card issuers due to security, durability and environmental issues what are the alternative card substrates?

This paper aims to look at the options open to card issuers, reviewing alternative substrates available in the market as well as highlighting a number of specific security features which can be used to ensure a credible, secure and long-life ID Card.

## Composite Cards

People often assume that an ID Card is made from a single piece of plastic and cut from a large sheet, but in reality a typical card includes multiple layers of white & clear PVC bonded together. The top clear layer is used to personalise the card with a photo, name and variable data of the bearer, whilst the internal layers contain the background design and print, including any security features. If the card is a Smart Card it will include electronics – such as a contactless chip or antenna – and these layers are sandwiched in between the other PVC core layers.



Diagram 1: A typical PVC Card structure with multiple layers

Composite Cards are different from 100% PVC Cards in that instead of constructing cards solely with layers of PVC, they utilise a range of different materials to add both the durability and security features demanded. The most common material to add to a Composite Card is PET, where the PET level can be 20%, 40% or 60% of the total structure. Another example of a Composite Card would be a PET/PETG Card (PETG core) where the PETG is similar to PVC but with increased resistance to bending. In both cases the addition of alternative materials adds significant durability to the card structure in comparison to PVC.



**Diagram 2: A typical Composite Card (PVC/PET) structure**

The need for more durable ID Cards has increased significantly as issuers are looking to maximise the lifespan of a card. Research from MorphoTrust who supply Driver License issuance materials and support to 42 states in the US, identified the move towards more durable cards occurring with the REAL ID federal mandate to better secure state driver licenses. <sup>1</sup>

This has meant that Composites Cards are now in many cases the go to option in the high-security identity document market, providing a more durable and secure ID Card solution in comparison to PVC. The PET, even at low levels, significantly aids durability whilst a PVC/PETG core will help to keep the overall costs down.

Importantly with these new Composite Card structures, issuers can use their existing equipment and consumables with a few small manufacturing process changes. For example, Composite PET/PVC Cards can still be personalised with ITW D2T2 Ribbons and the security and durability of the card can be increased by adding an ITW Laminate Patch or an ITW Overlay.



## Increasing security in Composite Cards - Achrogram™

Newly available for increased security is ITW Security Division's Achrogram™ feature which can be incorporated into a Laminate Patch or Overlay products, working well with Composite Card Structures and existing card equipment.

Achrogram™ is a colourless image with a matt white/black or positive/negative flip effect that switch when viewed at a 90 degree angle. This cannot be produced using standard laser origination techniques and is extremely difficult to copy or simulate. The surface area where the effect is applied will appear matt white and non-diffractive. All other areas will have a black non-diffractive appearance. When the image is turned 90° on its axis, exactly the opposite will occur, i.e. the black areas will become matt white and the matt white will become black.



Diagram 3: An example of the Achrogram™ effect available on ITW Overlays

## Polycarbonate Cards

Another extremely popular card substrate to add durability is Polycarbonate (PC). PC is a thermoplastic polymer with high temperature resistance and impact resistance. PC ID Cards are manufactured through the fusing together the different PC layers.

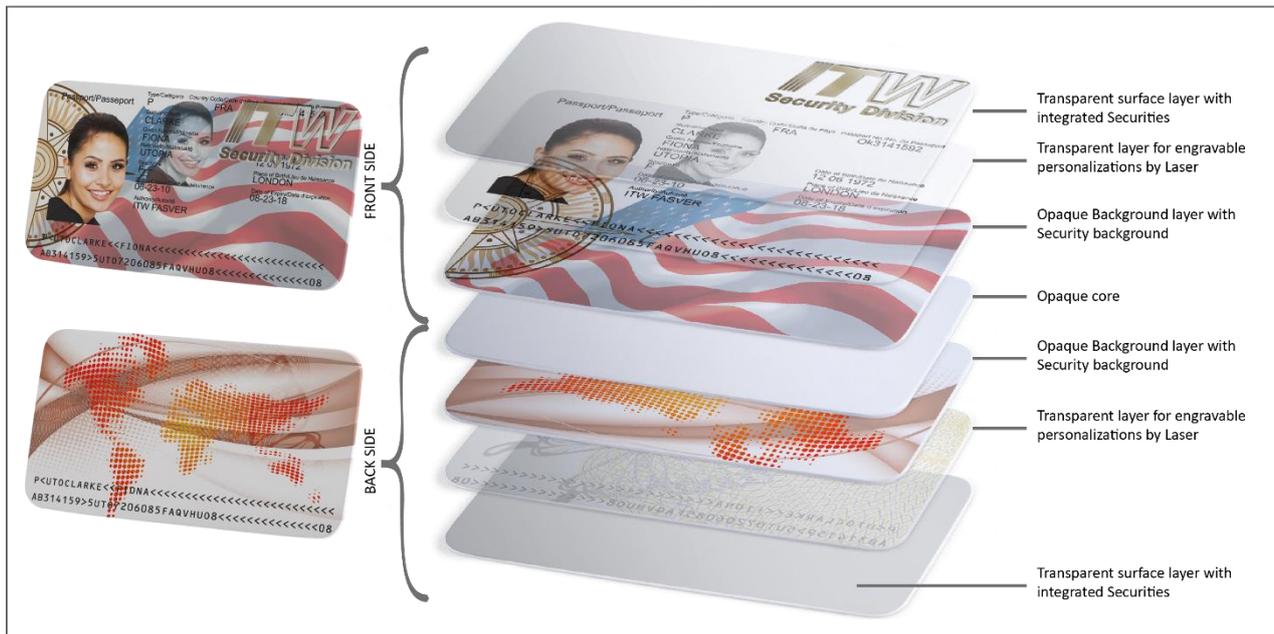


Diagram 4: A typical Polycarbonate Card structure

One of the many layers utilised is a laser engravable layer which enables the personalised data to be added by laser within the card structure rather than being printed on the top surface by a printer. This laser engraving capability combined with the high resistance polymer results in an extremely durable card with many card issuers, such as Gemalto, quoting a lifespan in excess of 10 years for polycarbonate identity documents.<sup>2</sup>

An additional benefit to PC is that its manufacture does not leave behind any dangerous residues and the disposal of any unwanted material does not give off any toxic gasses, meaning the material is regarded as more environmentally friendly when compared to PVC or Composite Cards.

## Security built in to PC Cards

Another major advantage of PC is the ability to embed security features within the many card layers thus making them less susceptible to tampering or counterfeiting including traditional security features such as guilloches/rainbow printing, screen-printing, OVIs, transparent and metallic holograms and ultraviolet inks.

ITW offer a range of products for PC substrates including **HoloPC** (Transparent Holograms), **PC Protek™** (Printed Polycarbonate Layers) and **Unichroma™** (D2T2 Ribbons for PC Substrates). Within PC Protek™, ITW can include some of their unique features such as OVTek® and Imaprotek®.

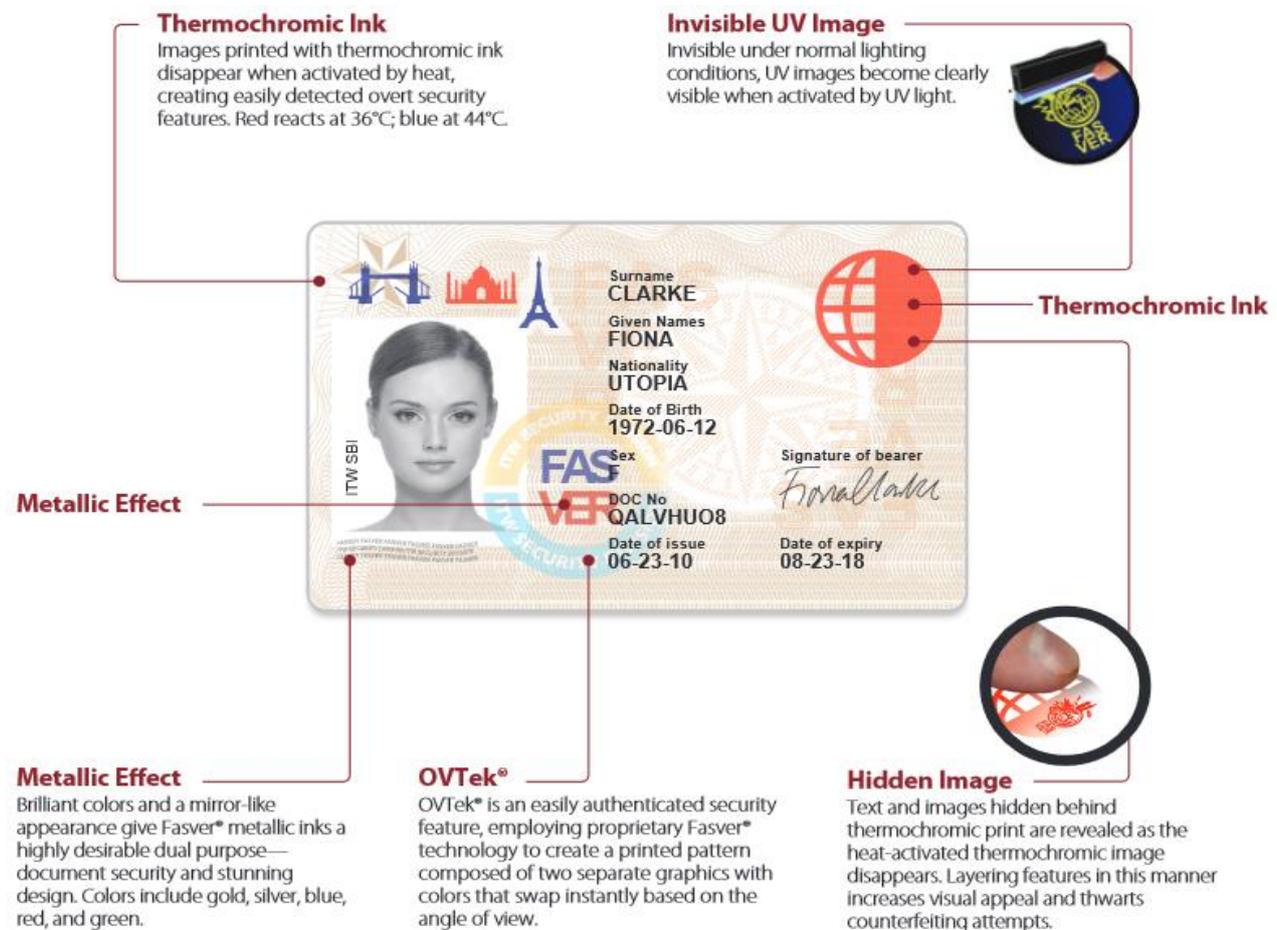


Diagram 5: PC Protek™ security layers enable card issuers to incorporate a wide range of patented and unique security features into PC Cards

## OvTek®

Ovtek® is a transparent colour shifting ink feature, or OVD, where patterns of two separate graphics are printed and whose colours swap instantly based on the viewing angle. The colours are bright and clear and yet biographical data can still be read through them and there are 6 different colour combinations available giving clients design choices and the inks are reactive to chemical, thermal and mechanical attacks.

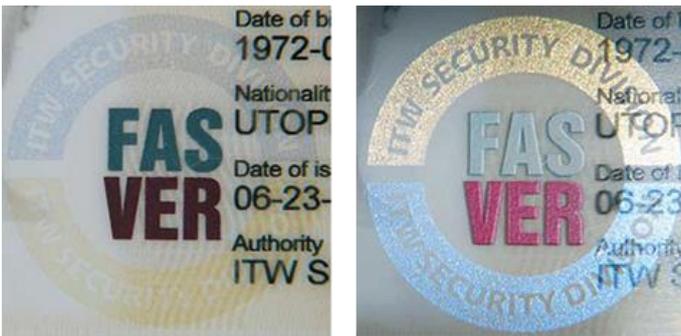


Diagram 6: Ovtek® is an easily authenticated security feature based on the angle of view.

## Imagram®/Imaprotek®

Imagram® is another example of a transparent ink feature from ITW. Here a diffractive variable photographic image is printed with excellent colour rendering and like Ovtek® the finished effect is transparent ensuring that the variable biographical data underneath can still be clearly read. The feature is printed in such a way that any attempt to tamper with the inks will be exposed.

Imaprotek® is another diffractive variable photographic image but visible only when exposed to UV light.



Diagram 7: Imagram®/Imaprotek® combines excellent colour rendering with exceptional transparency.



## Metallisation

Printing with highly reflective opaque inks helps accentuate other optically variable devices. Metallization cannot be reproduced using a printer, scanner or photocopier.

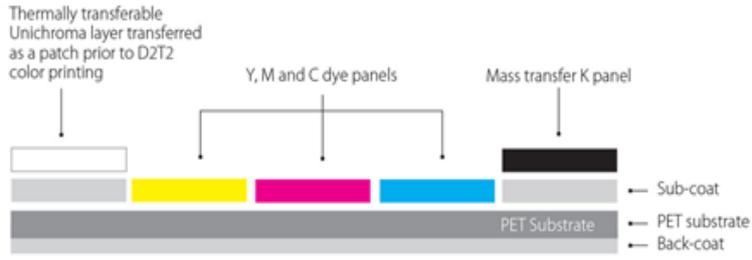


Diagram 8: Metallization with highly reflective opaque inks helps accentuate other optically variable devices.

## Unichroma™

Unique to ITW is a Dye Diffusion Thermal Transfer (D2T2) ribbon which allows colour images to be applied on to PC Cards and other difficult to print ID Card substrates. As a result, clients can cost effectively print colour photographs on their cards and even combine the printing with other laser engraved personalization, optimizing both ID Card security and ease of authentication. Whilst other colour personalisation solutions are available in the market they are often expensive and involve investment in equipment.

ITW's Unichroma™ will work with existing equipment giving cards issuers the option of moving to a more durable PC Card without tremendous additional expense. Unichroma™ can even be selectively applied to the card's surface only where colour is needed, thus minimizing further the cost per card.



Substrate	D2T2 Printable	Unichroma D2T2 Printable
PVC	Yes	Yes
PC	No	Yes
PET	No	Yes
PETix	No	Yes
PET-G	Sometimes	Yes
ABS	Yes - Low Density	Yes
Bio-PVC	Yes	Yes
PLA	Yes - Low Density	No
Paper	No	No

Diagram 9: Unichroma acts as a colour primer to improve the appearance of D2T2 printing on PC, without requiring special, expensive card stocks.

## Teslin®/Synthetic Papers

Whilst PC substrates grow in popularity due to their durability and security there are other disadvantages which open doors to other potential solutions such as a Teslin®/Synthetic Paper and PET combination.

Teslin® is a substrate material, manufactured by PPG Industries, which is placed in the core of a card and then personalised through printing and then laminated with PET to complete the card. PPG claim that it both makes the card resistant to de-lamination and increases the durability with better protection for any chips, antennae and other embedded electronics.<sup>3</sup>



Diagram 9: A typical Teslin®/Synthetic Paper structure

The composite combination of polyester and Teslin® lends itself better to machine-readable technologies. If the ID Card still contains a magnetic stripe, polyester composites are preferred in comparison to PC, which can crack with repeated swiping. Thus they are not usually used with machine-readable technologies other than bar codes.

PC Cards can also scratch easily and can be sensitive to chemicals such as acetone, toluene and acids. In a test carried out by ITW when a finished PC Card was placed in a bath of standard chemical products for 5 hours the 100% PC Card is clearly unusable while another option, the combined synthetic paper/ PET Card remained intact.



Diagram 10: The impact of chemicals on PC and PET card substrates.

## Tactile Effects with Synthetic Papers

ITW's Tesprotek product is a PET based product that works well in combination with synthetic papers. The paper core is sandwiched between two PET layers which can contain a number of unique security features such as OVTEK® and Imagram® and many more. Even level 1 tactile features can be included which are often described as one of the major advantages to PC Cards when Multiple Laser Image's / Changeable Laser Image's (MLI/CLI's) are included. The product can be supplied in sheets or rolls making it ideal for both desktop and central issuance. In trials conducted by ITW Security the security print features included within the finished cards achieve 10-year durability, exactly the durability achieved with 100% PC Cards.<sup>4</sup>



Diagram 11: Tactile effects can be integrated into synthetic cards



Tactile effects are simple yet very effective as Level 1 features. Whether a feature is there or not is a simple test but being able to emboss the feature deep enough and in perfect registration is not simple to do.

Whilst Teslin®/Synthetic Paper and PC Cards offer advantages and durability the manufacturing process for these cards is much more specific, needing specialist equipment, and the high heat and pressure required during the process can restrict some of the security feature options available.



## Summary

*PVC Card bodies are no longer the most secure, durable or environmentally friendly of substrates for ID Cards.*

Today's card issuers need to add greater security and Smart technologies to their ID Cards, meaning that they must deliver longer lifespans to justify the additional costs involved in these highly sophisticated projects. As already identified in this White Paper – Composite, PC and Teslin/Synthetic Paper Cards all now offer significant advantages in both durability and security in comparison to PVC.

So how to decide which substrate is best? Ultimately that will be the choice of the card issuer who after taking into account their unique issuance, personalisation and security requirements, will come to the best decision with their suppliers.

Whatever the chosen card substrate there is a wide range of potential security features to assist in the verification of genuine cards and prevent falsification and possible counterfeits.

ITW's extensive experience in providing security technologies and overlays across all card substrates mean that it is the ideal partner to support card issuers in their project to ensure a credible, secure and long-life ID Card.

<sup>1</sup><http://www.secureidnews.com/news-item/Card-tech-101-advanced-materials-secure-id-Cards> .

<sup>2</sup>[http://www.securitydocumentworld.com/creo\\_files/upload/client\\_files/polycarbonatejuly20081.pdf](http://www.securitydocumentworld.com/creo_files/upload/client_files/polycarbonatejuly20081.pdf)

<sup>3</sup><http://www.secureidnews.com/news-item/Card-tech-101-advanced-materials-secure-id-Cards/2>

<sup>4</sup>ITW Security's test based on: Xenon Arc Light Exposure (ISO24789-2012), UV-A Exposure (ISO4582 & DIN6167) and Temperature/Humidity/Dynamic Stress Bending (NFT 76-109 Cycle D4 & ISO10373-1)

## About Us – ITW Security Division

The ITW Security Division was formed in 2012 through the coming together of the management teams, technologies and resources of Covid®, Fasver® and Imagedata™. Leveraging the strengths of these brands, the ITW Security Division today offers the secure document market a single source supply for high security laminate documents and dye diffusion (D2T2) ribbons.

As an independently operated division of Illinois Tool Works Inc. (ITW), a Fortune 200 company, we have the financial resources necessary to continually invest in new technology, research and development. This global footprint and view has enabled us to supply products to more than half the world's countries from our secure facilities in the UK, France and USA.

At ITW Security Division we understand that the foundation for secure materials begins with highly secure manufacturing facilities. We manufacture products from start to finish in one of our secure facilities enabling us to meet the 'under-one-roof' production requirements demanded by many governments. Our products and technologies driven by our Covid® and Fasver® brands have developed a global reputation for highly advanced security solutions. Overt, covert and forensic security technologies are customised to the specific requirements of each document program to enable the widest combination of personalisation methods and substrates for passport and ID Card issuance worldwide. The companies within the security division include:

**ITW Covid Security Group Inc** was one of the world's first holographic and OVD manufacturers and now has over 25 years' experience. Located in New Jersey USA, the company is ISO14298 & NASPO (North American Security Products Organisation) accredited and manufactures all of its products under one roof, from holographic design and origination through to shim production, embossing, metallising, laminating, die cutting, converting and packing.

**ITW Imagedata** is a global manufacturer of consumables for the Card industry located in the UK, specialising in the design and manufacture of D2T2 (dye sublimation) ribbons that we supply exclusively to OEM Card printers. The company is ISO 9001 and ISO 14001 certified.

**Fasver® S.A.S.U.** is a global leader in the design and production of security products for the protection of personal data on identity documents including Passports & ID Cards. Located in Montpellier, France, the company is ISO & Intergraf accredited and their unique authentication solutions have been protecting documents for over 25 years.