



COLOUR PERSONALISATION FOR POLYCARBONATE IDENTITY DOCUMENTS

**Enhancing Security and User Experience
in Government-Issued Credentials**

Whitepaper

TOPPAN
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COLOUR PERSONALISATION IN POLYCARBONATE IDS: ENHANCING SECURITY AND USABILITY

In an era of evolving security threats and increasingly sophisticated counterfeiting techniques, governments worldwide face pressure to modernise their identity document systems. The proliferation of advanced printing technologies, readily available design software, and global criminal networks has made traditional identity documents more vulnerable to fraud than ever before. Simultaneously, citizens have come to expect government services that match the quality and sophistication of contemporary commercial offerings.

Recent statistics from Interpol indicate that document fraud cases have increased by 35% over the past five years, with counterfeit identity documents facilitating everything from illegal immigration to terrorist activities. The economic impact extends far beyond direct fraud losses, encompassing increased verification costs, administrative burdens, and the erosion of public trust in government-issued credentials. Although traditional monochrome personalisation methods have served their purpose, growing security concerns have encouraged the shift toward laser engraving as a more secure option. However, its technical limitations in colour reproduction have led to a considered compromise between security, visual clarity, and ease of authentication.

There have been several attempts to bring back colour to portrait personalization however, all the methods have their own drawbacks. We will explore laser colour technology on polycarbonate documents and why it is they answer for governments around the world.

OVERVIEW OF PERSONALISATION TECHNOLOGIES

When selecting personalisation technology for identity documents, government agencies must evaluate multiple printing methods based on security, durability, cost, and operational requirements. The three primary technologies—colour laser, black and white laser, and inkjet printing—each offer distinct advantages and limitations for identity document applications.

BLACK AND WHITE LASER TECHNOLOGY



Black and white laser personalisation offers proven security benefits with simplified operational requirements compared to colour systems, making it suitable for applications where colour elements are not essential.

Technical Characteristics: Greyscale laser systems use focused laser energy to create permanent black personalisation within polycarbonate documents.

Security Advantages: Black and white laser personalisation provides excellent tamper-evidence, as any alteration attempts result in visible substrate damage. The technology supports various security features including microtext, complex patterns, and variable data elements. Whilst lacking the authentication layers of colour systems, monochrome laser personalisation still offers substantial security improvements over surface-applied methods.

Quality and Durability: Monochrome laser systems produce crisp, high-contrast text and images with excellent edge definition. The permanent integration ensures long-term stability without degradation. However, the aesthetic appeal is limited compared to colour alternatives, and photograph reproduction lacks the quality law enforcement and citizens expect from modern identity documents. It reduces the level of visual fidelity, as colour tones contribute to the overall appearance of the portrait—similar to the photo stored in the chip and the facial features assessed by border control officers.

Operational Considerations: Black and white laser systems require lower initial investment and simpler maintenance compared to laser colour alternatives. Production speeds are typically higher, and operator training requirements are reduced. Environmental control needs are less stringent, though still important for consistent quality output.

COLOUR LASER TECHNOLOGY

Colour laser personalisation represents the most advanced option for identity document production.

Technical Characteristics: Colour laser personalisation systems embed images into the document by using precisely controlled laser energy which results in content that becomes an integral part of the document's structure rather than simply being printed on its surface.

Security Advantages: The integration of colour elements creates multiple authentication layers that are extremely difficult to replicate. Tampering attempts result in immediate visible damage to the document, as the colour elements cannot be removed without destroying the substrate. Additionally, colour laser technology supports sophisticated security features including rainbow printing, colour-shifting elements, and multi-spectral authentication patterns.

Quality and Durability: Colour laser personalisation produces exceptional image quality with sharp detail reproduction and consistent colour accuracy. The embedded nature of the personalisation ensures long-term durability, with no fading, peeling, or surface wear typical of traditional printing methods. Documents maintain their appearance and security features throughout their intended lifespan.

Operational Considerations: Colour laser systems require significant initial investment and specialised operator training. Personalisation speeds are generally slower than other methods due to the complexity of the colour integration process.

Environmental controls are critical for maintaining consistent output quality, and ongoing maintenance costs are higher due to system sophistication.

INKJET PRINTING TECHNOLOGY



Inkjet printing represents the most cost-effective personalisation option but offers limited security benefits and durability compared to laser-based alternatives.

Technical Characteristics: Inkjet systems apply liquid inks to document surfaces using precise droplet placement technology. Modern systems can achieve high resolution output with good colour reproduction, but the personalisation remains on the document surface rather than integrated into the substrate.

Security Limitations: Inkjet personalisation provides minimal security benefits, as surface-applied inks can be removed or altered using various techniques. The technology offers limited tamper-evidence and cannot support advanced security features available with laser systems. Authentication relies primarily on document design rather than personalisation technology.

Quality and Durability: Whilst modern inkjet systems can produce excellent image quality, the surface application makes documents vulnerable to wear, fading, and environmental damage. However, the varnish added on top reduces the overall quality. Colour reproduction

may vary over time, and physical handling can cause deterioration. The technology is unsuitable for high-security applications requiring long document lifespans.

Operational Considerations: Inkjet systems offer the lowest initial investment and simplest operation. Production speeds can be high, and maintenance requirements are minimal. However, reoccurring consumable costs can be significant, and quality consistency may vary with environmental conditions and ink aging.

HYBRID APPROACH: GREYSCALE LASER WITH INKJET SURFACE PRINTING

Some government agencies have attempted to bridge the gap between security and colour quality by combining greyscale laser personalisation with surface-applied inkjet colour printing. This hybrid approach uses black and white laser technology to create secure, tamper-evident personalisation within the polycarbonate substrate, whilst adding colour elements through inkjet printing on the document surface.

Whilst this combination attempts to deliver both security and colour, it inherently compromises on both fronts. The greyscale laser component provides substrate integration and tamper-evidence for the monochrome elements, but the colour portrait remains vulnerable to the same security limitations as standard inkjet printing. The surface-applied colour can be altered, removed, or damaged through physical handling, creating a two-tier security system where the most visually prominent element—the colour photograph—is also the least secure component.

FROM A QUALITY PERSPECTIVE, THIS HYBRID APPROACH ALSO PRESENTS CHALLENGES.

The inkjet colour elements require protective varnish layers to improve durability, but these coatings reduce overall image quality and create a visible distinction between the laser-engraved areas and surface-printed regions. Additionally, the inkjet covers and laser-engraved part of the photo, which prevents a clear assessment of whether the image has been tampered with. This limitation is frequently cited by law enforcement and security specialists as a major drawback—often ranking as their least favoured option for that specific reason, even before considering durability concerns.

The document exhibits different tactile properties and visual characteristics across its surface, creating an inconsistent user experience. Furthermore, the surface-applied colour elements remain susceptible to fading, scratching, and environmental degradation over the document's lifespan, whilst the laser-engraved monochrome elements maintain their integrity. This creates documents that age unevenly, with colour photographs deteriorating whilst text and security features remain pristine—a situation that can complicate long-term verification and may necessitate earlier document replacement.

COMPARATIVE ANALYSIS

Security Ranking:

- 1. Colour laser** (highest security)
- 2. Black and white laser** (excellent tamper-evidence with substrate integration)
- 3. Greyscale laser with inkjet surface** (mixed security profile with vulnerable colour elements)
- 4. Inkjet** (minimal security benefits)

Quality Ranking:

- 1. Colour laser** (superior image quality and aesthetic appeal)
- 2. Greyscale laser with inkjet surface** (inconsistent quality with surface vulnerabilities)
- 3. Black and white laser** (excellent text quality, limited aesthetic options)
- 4. Inkjet** (acceptable quality with durability limitations)

For high-security identity documents requiring maximum fraud resistance and citizen satisfaction, colour laser personalisation represents the optimal choice. The technology provides unmatched security benefits whilst meeting contemporary expectations for document quality and appearance.



VERIFICATION BENEFITS OF COLOUR PORTRAIT INTEGRATION

The implementation of colour portrait photography in identity documents fundamentally transforms the verification process, providing border control officers, law enforcement personnel, and document verification staff with significantly enhanced authentication capabilities.

Visual Fidelity

Unlike traditional black and white photographs, colour portraits preserve crucial identifying characteristics such as skin tone variations, natural eyecolour ranging from subtle hazel patterns to distinctive heterochromia, and hair colour gradations including natural highlights, grey streaking, or auburn undertones that appear identical in monochrome images. The enhanced detail resolution available through colour laser personalisation technology captures subtle facial characteristics including rosacea patterns on cheeks, vitiligo patches, distinctive birthmarks with colour variations, liver spots, and natural freckling patterns that would be completely invisible in black and white reproduction. Additionally, colour portraits reveal important distinguishing features such as the natural reddish tint of eyebrows that may appear darker in hair colour, subtle colour differences in facial hair including ginger beards on individuals with brown hair, and the natural flush variations in lip colour that can serve as secondary identification markers. This improved visual fidelity enables verification personnel to conduct more confident and accurate identity confirmations, particularly in challenging lighting conditions or when examining documents that have experienced normal wear and handling.

Security

Furthermore, colour portraits integrated through laser personalisation technology are virtually impossible to substitute or alter without causing obvious damage to the document substrate, providing verification officers with immediate confidence in the photograph's authenticity. The psychological impact of colour photography also contributes to verification effectiveness, as the enhanced realism and professional appearance of colour portraits make subtle alterations more apparent to trained personnel, whilst simultaneously increasing the document holder's confidence in presenting their credential for inspection.

FUTURE TRENDS AND TECHNOLOGICAL DEVELOPMENTS



The industry continues to evolve, with emerging developments that could bring even capabilities and security enhancements. Advanced colour management systems are incorporating artificial intelligence for automated quality control and colour matching, reducing operator intervention requirements whilst improving consistency.

Integration with biometric authentication systems could represent a significant growth area, with colour personalisation which could enable complex biometric template storage

and verification features. These developments support the implementation of advanced multi-factor authentication systems that combine traditional visual verification with biometric validation.

Sustainability considerations are also driving innovation, with manufacturers developing eco-friendly pigments and energy-efficient processing systems. These advances address growing government requirements for environmentally responsible procurement whilst maintaining security and quality standards.

HOW CAN YOU MOVE TO A COLOUR PORTRAIT?

Government agencies considering colour personalisation implementation should begin with comprehensive needs assessment and stakeholder consultation. This process should evaluate current security requirements, infrastructure, and operational constraints to develop appropriate implementation strategies.

Pilot programmes offer valuable opportunities to test colour personalisation capabilities whilst minimising risks and costs.

Partnership with experienced technology providers is essential for successful implementation. Providers should offer comprehensive support including training, maintenance, and ongoing technical assistance to ensure optimal system performance and operational success.

CONCLUSION

Colour personalisation represents a transformative technology for government identity document programmes, offering significant security enhancements whilst improving citizen experience and operational efficiency. The technology's ability to create tamper-evident, high-quality personalised documents addresses critical security needs whilst supporting modernisation objectives.

Successful implementation requires careful planning, appropriate investment in infrastructure and training, and partnership with experienced technology providers. However, the long-term benefits in terms of security enhancement, cost reduction, and citizen satisfaction make colour personalisation a strategic imperative for forward-thinking government identity document programmes.

Colour personalisation will become increasingly accessible to government agencies of all sizes, making it an essential consideration for any identity document modernisation initiative.

