

The Issues in Printing Security Documents Which Have Intrinsic Value

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Abstract

Valaurum, Inc. is currently producing security documents which consist of a PET plastic substrate, printed images, covered by a thin layer of pure gold, and laminated by a PET topcoat. The printing may depict proprietary objects, a merely artistically beautiful image or representations of official currency. These printed objects, called Aurum™, have intrinsic value due to their typically containing .05 to 0.25 grams of pure gold. They may, however, have far greater value as collector's items, special commemoratives or their relation to currency. The factors involved in the incorporation of "security features" as well as the inherent complexity of the gold content lead to interesting security printing decisions. For many potential buyers, the production of the Aurum would require adherence to ISO 14298, the management of security printing standard. The complexities involved in producing security documents under the aegis of the ISO 14298 standard will also be discussed.

Security Printing Considerations

Security printers must be able to produce security products that can be tracked/traced and authenticated by themselves and/or their customers, especially in the case of disaster or failure. This entails the adoption by the security printing organization of the principles contained in the ISO standard 14298, Management of security printing processes. These principles include: conducting risk assessments of all the steps in the process of going from creative design ideas to finished products in the hands of the final customers. Some examples of the unique areas of risk for the printing of security documents are:

Policies on the risk prevention of Theft, Damage, Sabotage and Loss.

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- a. Serial numbers will be controlled and status of the security documents (in process, in storage, in circulation, to be withdrawn, destroyed) versus their serial numbers will be maintained in secure storage places and secure files, e.g. specially encrypted locations.
- b. That is, as security documents are printed the serial numbers will be traced; if a series of such documents are ruined, lost, damaged, etc. the serial numbers will be coded to so indicate. Physical lots of the security documents will be tracked by the serial numbers, as circulated, if damaged, even to destruction, for example.
- c. Transport of all valuable materials, including printed substrates, gold, sputtered substrates, final specie will be via “dummy shipping procedures” to insure shipper has no knowledge of value of cargo.
- d. Security printers shall provide that every facility that provides a production step for the documents, from creative design through final shipments to customers, has a facility security policy which covers physical security measures, personnel screening and use of equipment.
- e. RFID or other suitable devices will be attached to all shipment containers.
- f. Personnel who are in the production chain will be screened for reliability. (see personnel policies)
- g. Where outside vendors perform tasks, personnel or representatives of the security printing company will escort the work.

Customer related risk-

- a. For ostensible “currency” purchases, customer risk relates to the authenticity of the security document; the security printing company must provide for processes to ensure that the final security documents are authentic based upon control of printing files, printed substrates, gold-coated species and final products.
- b. The issue of customer misusing Aurum products seems moot as the only inherent value to Aurum is gold content which cannot be forged or misused. (The only caveat is whether a forger can match their appearance with reduced gold content and the customer never checks the gold content. This scenario should drive Valaurum to develop non-destructive analyses for their gold content)

The 14298 standard includes many more risk assessment guidelines, but the above examples provide the idea of how much more complicated the requirements are for security documents (esp. for use as currency). There are other requirements including the establishment of security objectives. Such objectives must be independently verifiable and capable of auditing by outside third parties. This verifiability requirement is well known to organizations who adopt the ISO 9000 class of standards. Basically, an organization must define in detail what its operational procedures and policies are and define them in a way such that an

independent auditor can understand them and confirm that they are being followed. Typically, this includes drawing up an operational plan which provides control of the production processes by means of monitoring, measurements and analyses.

The operational plan might include:

The top management responsibilities (spelled out).

The necessary processes involved in producing the security documents.

How the processes are monitored to insure compliance with the security plan.

A full security plan has even more details, but this indicates how comprehensive a security printer must be to be fully compliant with ISO 14298.

The Nature of the Aurum™

Production of the Aurum starts with a printed image. The image (often incorporating special graphical features) is printed using novel UV inkjet inks on a high-end inkjet press. Gold is deposited onto the printed PET film in a very precise manner ensuring uniformity of the coating (where desired) or in a pre-designated pattern, where that is desired. A second PET film is then laminated over the gold deposited layer to make a “gold sandwich” which is the Aurum product. Possible security features connected to the printing process are discussed below, however, the process of printing onto PET with UV cured inkjet inks has entailed significant developments. The printer, substrate, ink, curing and deposition technologies are described in more detail. While the following paragraphs describe the process used by Valaurum they are meant to provide an example of the details which a security printer must adhere to so that the final security documents will be accepted by potential customers.

PRINTER:

Figure 1 summarizes the key factors used to determine which printer among the high end industrial scale inkjet printers was best to print the security documents. Printer F was chosen as having the best compromise among speed, resolution, price and overall quality. It prints CMYK plus White and Clear Coats at resolutions up to 1440 X 1440. The printer can handle a vast array of press stock- either roll-to-roll or sheet fed. The press uses special large UV LED lamps to expedite production and promote ink adhesion. It is equipped with two high-precision 6 color print heads which deliver full high quality commercial grade resolution and color quality in all print modes and on a variety of substrates. The printer design incorporates an automated media take-up system that facilitates precision printing, that is, the unit includes an advanced tension-controlled take-up system for optimum media feed and tracking. Stretching of the plastic and buildup of static charges are minimized to maintain printing accuracy.

Printer:	Printer A	Printer B	Printer C	Printer D	Printer E	Printer F
# of Nozzles	1440	1440	2560	2560	1440	1440
Ink Type	Solvent based	Solvent based	Water based	Latex based	UV Solvent based	UV Solvent based
Color Options	CMYK x 2	CMYK x 2	CMYK	CMYK x 2	CMYK	CMYK + White & Clear
Max Media Width	64 inches	54 inches	60 inches	63 inches	64 inches	54 inches
Relative Print Speed	1	1	0.55	1	0.55	1.23
Take-up System	Yes	Yes	Yes	Yes	No	Yes
Relative price	Middle	middle	cheaper	cheapest	most expensive	2nd most expensive
Media Type	PET A	PET A	PET A	PET B	PET B	PET B
Thickness Available	2, 3, 5 mil	2, 3, 5 mil	4 mil	3 mil	3 mil	3 mil
Converting	Automated	Automated	Manual	Manual	Manual	Automated

Figure 1. Comparison of Drop-On-Demand Piezo inkjet

SUBSTRATE:

The substrate used is high performance PET film with unique characteristics that are critical in the final construction of security documents. These document substrates must possess an exceptional combination of optical, physical, mechanical, thermal, and chemical properties, especially resistance to tearing. Besides the obvious need for high transparency, security substrates must show: excellent durability after frequent handling, resistance to household chemical insults, ease of production handling and receptivity to the printing media. Many of these characteristics are obtained as a the direct result of a special film manufacturing process which provides the high clarity film. Both sides are pre-treated to promote adhesion to most printing inks and industrial coatings. The high tensile and tear strength of the substrate material aid in high-tension conversion processes. The density and strength combined make constructions of the substrate highly durable. The material also offers a suitable water barrier and low water absorption. In addition, it has a high service temperature range (-70oC-150oC). These properties are critical in the metallization of the film (often at elevated temperatures) and in laminating and converting operations. Screening of numerous potential substrate materials has been carried out to reach the decision on the currently utilized PET material.

Inks:

The Eco-UV inks feature instant UV-cured drying and print to high density and a wide color gamut. Due to the flexibility of the dried ink films prints they can be stretched around curved surfaces and edges and do not crack. The press has an automated ink circulation system that prevents pigment settling in the ink lines which allows for reliable production. The UV ink is formulated to offer superior scratch and chemical resistance. The UV-curing system uses safe, low heat LED lamps that last up to 10,000 hours. The inks have a wide color gamut and excellent resistance to fading, discoloration, weathering, etc. Performance of the ink system must adhere to critical requirements built into the security printing objectives. Figure 2 below summarizes the tests conducted to determine the suitable combination of substrate and ink which enables a durable security document which will not fall apart or delaminate in normal usage.

Test #	Ink Type	Print Substrate	Laminating Substrate	Result
1	Eco-Ultra Solvent Based	PET A	Thermal laminate	FAIL
2	Eco-Ultra Solvent Based	PET B	Thermal laminate	FAIL
3	Water Based	PET B	Thermal laminate	FAIL
4	Latex Based	PET B	Thermal laminate	FAIL
5	UV Solvent Based	PET B	Thermal laminate	PASS

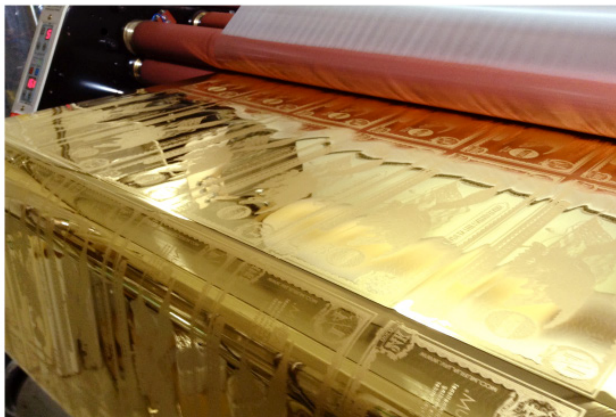
Figure 2. Aurum Construction Trial Results following ASTM F2296

SOFTWARE:

Included with the printer is special Arziro software that combines powerful features with an easy-to-use interface. The security software supports a color system, which accurately reproduces more than 1000 standard colors. It also features a built-in PANTONE library which automatically converts specific PANTONE spot colors in a design to a CMYK value. The security printing package provides direction for utilizing manifold security printing features, including those described in the section below and many original or unique attributes. To meet the stringent security printing management protocols, the actual printing files are maintained in secure and protected keys.

GOLD DEPOSITON:

Beyond the printing and graphic security features Valaurum has the unique capability of utilizing the gold depositions process (or processes) to effect new security characteristics. Variations in how the gold is deposited create traceable security features. Particular to the Aurum is the fact that it does contain gold in a PET sandwich; it is a gold bullion product which utilizes 21st century printing technologies. Figure 3 shows an example of Aurum coming out of the gold deposition process.



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Figure 3. Rolls of Aurum coming out of the gold coating process

Security Printing Features

While secrecy considerations prevent discussion of the details of security features incorporated in the Aurum, we can look at descriptions of security features discussed in several TAGA proceedings. Inkjet (unlike intaglio or offset) allows unique images for each individual document allowing incorporation of serial numbers and security features unique to each document tied to its serial number. Examples of possible security features might include the use of holograms, as described by Faucoli (1988), Other features include superposition of 2D bar codes, as described by Maleshliyski and Garcia (2009) or color shifting media as described by Tyagi (2013). One could also describe the needs of security printing by highlighting that the security printer must also be concerned with monitoring and producing acceptable continuous fine-line images, as most printing solutions and security printing devices rely on their faithful reproduction.

Finally, one special application concerns the currency possibilities. In format and appearance Aurum can be easily designed to depict a currency instrument, esp. in view of recent developments of plastic based currency offered by many governments around the world. The technology is easily adapted to make the Aurum look like a standard government note, a dollar, a pound, a peso etc. It is especially intriguing to third world countries as the inherent gold content provides a base value that the holder knows he can always cash the note for. Where fears of runaway inflation are real this is a big advantage over paper currencies. In a stable environment, the government can print the currency bill at a denomination valued at five or even ten times the gold content, providing a money-making opportunity. Figure 4 below summarizes the security aspects to the Aurum product.

Cutting Edge Precious Metal Anti-Counterfeiting

- Atomic Printing
- Microprinting
- Encrypted Serial Numbers
- Linked QR Codes
- Gold on Display
- Four More Features Planned in 2016



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Figure 4. Security aspects to the Aurum product

Conclusions

The processes involved in printing security documents have been summarized using the example of the Aurum. The Aurum is unique in being a sandwich of a printed PET layer, a gold deposited layer and a PET laminate covering the gold deposited layer. However, the concepts and processes used to meet the requirements of ISO 14298, Management of security printing processes, are similar for the Aurum and other security documents. This paper highlights the many issues concerned with meeting security printing requirements.

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