This note aims to share the experience of IGNA using the new Lumicyano based fuming protocol. In addition to the results on fingerprint development, this note reports the compatibility of the Lumicyano technology with DNA analysis. This new technology provides a rapid and highly detailed fluorescent fingerprint development thus allowing both papillary and genetic identification on a single mark.

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Introduction

The routinely use of DNA analysis in criminal cases resolution has drastically modified the habits of Forensic forces around the world. Indeed, DNA is present everywhere and only drops of blood, semen, flakes of skin, hairs or drops of saliva can be used to identify a suspect. However, even if small amount of DNA material is sufficient to perform DNA analysis, DNA prints can be easily contaminated and required cautious sampling methods and examinations. In addition, DNA identifications have always been a matter of probability and even if the scope of error is slight, unquestionable identifications often require multiple identifications to be procedurally admissible for the legal system. Beside circumstantial evidences, fingerprints left by individuals on a crime scene are often brought together with DNA identification to the court to identify perpetrators. Several fingerprint development protocols are used by Forensic facilities around the world. Among them, cyanoacrylate fuming and dactyloscopic powder (carbon or fluorescent powder) development are the most widely used. Dactyloscopic powder can be used easily on a crime scene to obtain raw identification on non-portable evidences (walls, doors or windows). However, as soon as portable evidences (weapons, papers…) can be carried to a fuming cabinet, cyanoacrylate fuming clearly outclasses powders in terms of resolution, papillary ridges detail and overall fingerprint quality. Even if fingerprint development is a widely studied field in the Forensic Science community, performing fingerprint identification and DNA analysis on a single mark is merely impossible when a two-step process is needed (fuming + dying): DNA evidences are no more useable. In this context, a new technological solution has emerged and claims to combine all the advantages of a standard cyanoacrylate fuming process combined with a fluorescent dye incorporation leading to the development of high resolution fingerprints compatible with DNA sampling: Lumicyano™. It provides fluorescent fingerprints in 30 minutes without any chemical post-treatment thus without damaging the genetic material. In this case, DNA analysis may be still possible to perform, even after latent print fuming.

1/ IGNA (Institute of Genetics of Nantes Atlantique) : a key player of the French legal system

In 2003, IGNA was founded with around more than twenty scientists of the Nantes hospital. Based on over 15 years of experience in molecular genetics, IGNA is the first automated and computerized French laboratory dedicated to the medico-legal human genetics. IGNA is present in Nantes and Marseille, both sites being accredited by the French Accreditation Committee (COFRAC) for the standard ISO 17025 since August 2010. The aim of IGNA is to carry out large number of analysis within controlled turnaround in agreement with the international standards, ensuring total traceability and reliability of results. Since its creation, IGNA carried out genetic expertise at the request of magistrates or investigators, within the framework of criminal files, and analyzed hundreds of thousands of samples.

With a processing capacity reaching 25,000 genetic profiles a month, totaling 300,000 profiles yearly, IGNA was elected to supply the French National DNA Database (FNAEG). In addition of genetics, IGNA has developed recognized skills for friction ridge development combined with DNA profiling. IGNA is accredited by the French Accreditation Committee (COFRAC) since 2010 and has developed a Quality Management System that meets international standards ISO 9001 and EN ISO / IEC 17025.

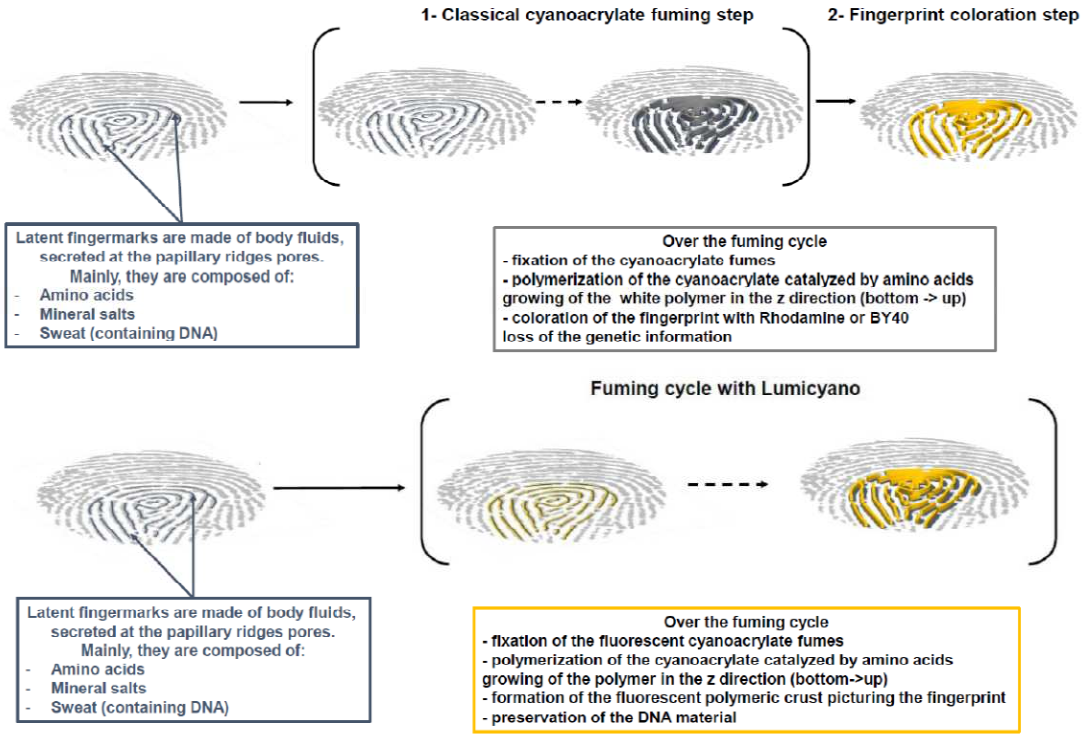
2/ Fingerprint (Friction ridge impression) development

2.1/ Classical fingerprint development technics: time-consuming and DNA-incompatible protocols

Fingermarks consist of body fluids made of sweat, amino acids or mineral salts secreted through the friction ridge pores. In classical fuming processes, when cyanoacrylate fumes are in contact with the latent print, some of the chemical species (especially the amino acids) initiate the polymerization of the fume to form a thin crust of white poly-cyanoacrylate, picturing the fingerprint. At this stage, the genetic material is kept intact under the polymeric shell. However, in most of the cases, an additional step is often required to enhance the contrast between the fingerprint and the background. Such additional treatment involves the use of dyes (rhodamine or Basic Yellow 40 for example) most of the time based on toxic solvents (methanol) and is highly time consuming (up to 48h). Much more, theses dyes may react with the substrate and cannot be applied on semi-porous surfaces or directly on the crime scene. As a consequence, the overall fingerprint quality may be altered and all the genetic information lost.

2.2/ Lumicyano, the one-step and DNA-compatible fluorescent cyanoacrylate fuming process

Lumicyano is a new technology which allows the one-step fluorescent development of latent fingerprints. It consists of a specially calibrated cyanoacrylate and a dye which the operator has to mix before starting a fuming cycle. At the end of the fuming process, in a 30 - 45 minutes period of time, the fingerprints are directly fluorescent under Forensic lightning. This technology allows highly detailed development on every non-porous and semi-porous surfaces. There are no needs for further post-treatment with toxic chemicals like in the case of Rhodamine or Basic Yellow staining protocols. The overall quality of the fingerprint is therefore enhanced and the genetic information is saved. Indeed, the thin polymeric crust formed in the fuming cycle is directly fluorescent so does not require the use of dyes and toxic solvent. In addition, there are no interaction between the Lumicyano and the genetic material. As a consequence, the genetic material stays intact after the fuming process and available for genetic profiling. Indeed, it allows unique opportunity to do DNA sampling on wide volume like rooms or vehicles which were exposed to fluorescent cyanoacrylate fumes to developed latent marks.



3/ The technical validations of IGNA

3.1/ Lumicyano as fingerprint revelation protocol

IGNA performed a technical validation of the Lumicyano technology. Fumigation cycles were performed in accordance with standard casework protocols. Briefly, 80 mg of Lumicyano Powder was dissolved with 2g of Lumicyano Solution leading to a fluorescent cyanoacrylate mixture at 4 % of dye as recommended by the manufacturer. Fuming cycles were performed on a commercially available fuming cabinet (670 L / 23.6 ft^3) at 120°C (250°F) with a hygrometry ratio of 80%. These settings correspond to the user guidelines of Lumicyano for an optimal development of fingerprints. After fumigation, revealed fingerprints were observed under UV with a lamp Super Xenon manufactured by Labino (UV Forensic lightning - 325 nm). Pictures were taken with a camera equipped with an orange filter (Tiffen Orange 16 : high-pass 520 nm). Several types of plastic surfaces were tested with consistent results: Lumicyano provided highly detailed fingerprints for all the type of plastic surfaces tested. The prints were directly yellow fluorescent thus not needing any chemical post-treatment. As such, Lumicyano provided both a considerable saving of time and development quality as compared with the old protocols. Indeed, Rhodamine or Basic Yellow 40 staining steps usually take up to 48h to get fluorescent prints while fluorescent powder used to enhance the fingerprint contrast provided poor friction ridges resolution. In addition, the overall Lumicyano-developed fingerprint quality was greatly enhanced in terms of details and resolution thanks to the absence of chemical or physical treatment which was altering the fingerprint. More importantly, DNA material stays available for DNA profiling, even after the fuming step.

➔ **Lumicyano outclasses all existing fingerprint revelation protocols.**

3.2/ Compatibility of Lumicyano with DNA sampling

The DNA compatibility of the Lumicyano technology was demonstrated by IGNA. A systematic comparison was performed between DNA extracts subjected to a Lumicyano fuming cycle and straight

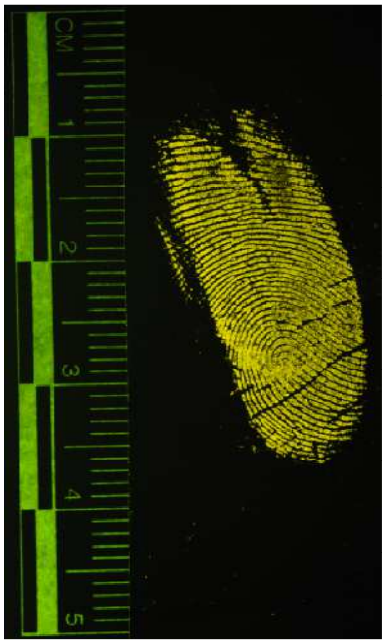
DNA extracts deposited on plastic surfaces. The sampling and analysis protocols used have been validated by the French Accreditation Committee (COFRAC) in accordance with the two accreditations ISO 9001 and ISO/CEI17025. According to the policy of the institution, all the standard casework precautions were taken. All the records emphasize a quantitative matching between fumed and untreated DNA extracts. It is noteworthy that even if you heat the Lumicyano to 120°C during the fuming process, the fingerprint stays at room temperature, thus not damaging the genetic information. Only a slight difference was denoted when DNA extracts were diluted (1/100). Indeed, in the case of fumed samples, a slightly lower quality of the DNA profile, especially the number of valid system for genetic profiling, could be recorded. Such difference arises from the sampling protocol itself. Indeed, the fumigation process consists basically to cover the traces with cyanoacrylate (superglue). It is therefore more difficult to swab off the DNA traces. However, the proof of principle was demonstrated and the Lumicyano technology is compatible with genetic profiling. As a consequence, IGNA has replaced the previous cyanoacrylate fuming process by the Lumicyano and all the fingerprints development are now performed with this one-step fluorescent fuming process.

➔ **Lumicyano is compatible with DNA sampling and identification**

4/ Real casework application

Double identification with fingerprint and DNA on a single mark thanks to the Lumicyano technology

In a homicide case, the victim credit card was robbed for cash withdrawing by the criminal. Luckily, the credit card could be retrieved from the ATM and IGNA was able to perform a double identification (fingerprint followed by DNA analysis) on the same evidence. As a non-porous surface, the credit card was the perfect candidate for such double identification. The fuming of the credit card revealed high quality fingerprints, and identity of the perpetrator was further confirmed by DNA analysis. This double identification made the suspect confess to the crime he was suspected of.



5/ IGNA general satisfaction with Lumicyano

Lumicyano gave impressive results in terms of fingermark revelations. As a one-step process, it outweighs conventional two-steps processes involving successive fuming and dying steps. With a processing time reduced from 48h to 30 minutes and a much higher detailed development, Lumicyano plenty satisfies the high standards of both IGNA and French legal system. In addition, there are no chemical interactions between Lumicyano and the genetic material trapped under the thin fluorescent polymer crust picturing the latent. As it stands, it is now possible to perform the fluorescent development of latent fingermark followed by DNA profiling on a single mark. These advantages have made Lumicyano the favoured revelation technic and is now used on a daily basis by IGNA scientists.

➔ **Lumicyano makes possible both fluorescent fingerprint development and DNA profiling on a single mark**

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