Nucleation and Growth of Silver in Physical Developer – From Ion to Fingerprint

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1. FINGERPRINTS

Fingerprints are a powerful means of **identification** due to their **unique** nature – no two individuals will have the same fingerprint. This is due to the characteristic **ridge details**.

Fingerprint classification is split into three categories:

- Primary level – The pattern type: loop, arch or whorl (figure 1)
- Secondary level – Ridge features (figure 2)
- Tertiary level – Sweat pores (figure 2), ridge shape or thickness

Loop **Arch** **Whorl**

Figure 1

Figure 2

Any surface that is touched results in the transfer of sweat residue from finger to surface = a **latent** fingerprint. These marks are '**invisible**', therefore they must be **visualised**.

2. PHYSICAL DEVELOPER (PD)

PD is a widely used method for the detection of latent fingerprints on porous surfaces[1], notably paper, based on the redox reaction:

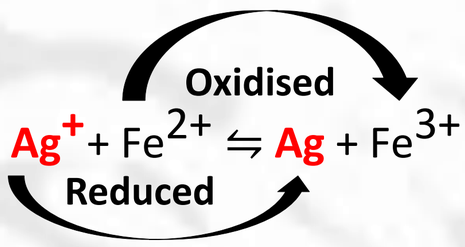

Figure 3

Silver ions in **solution** are reduced and **selectively** deposited onto the **fingerprint residue** resulting in a **positive** image.[2]

PD is the only method that can be used on porous surfaces that have previously been wetted, for example, incriminating documents or paper currency thrown into a river.

Though a widely used and effective technique, the underlying chemistry of PD is poorly understood.

→ How do the silver particles behave in solution compared to the surface?

→ What is the microscopic appearance of these particles?

3. SILVER STORY

Figure 4

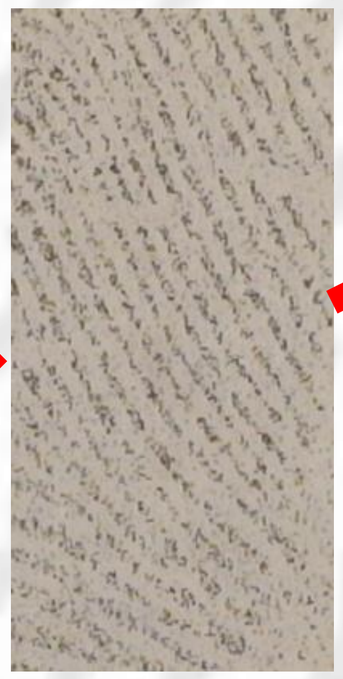

Figure 5

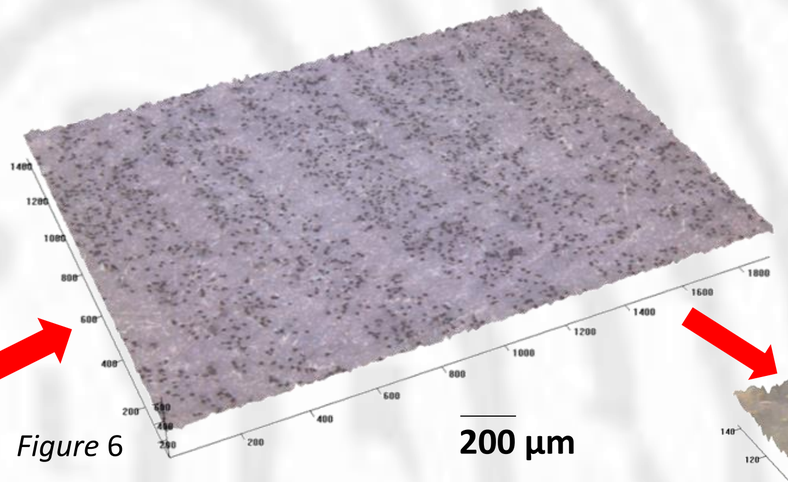

Figure 6

Silver particle size on the **surface** - 14 - 20 µm

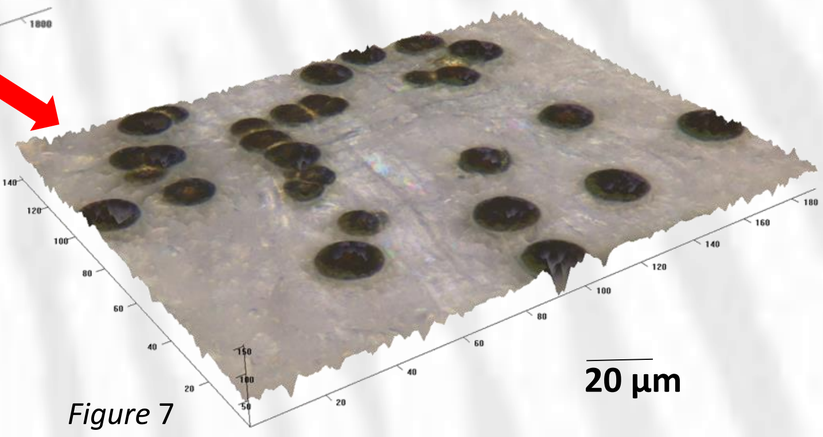

Figure 7

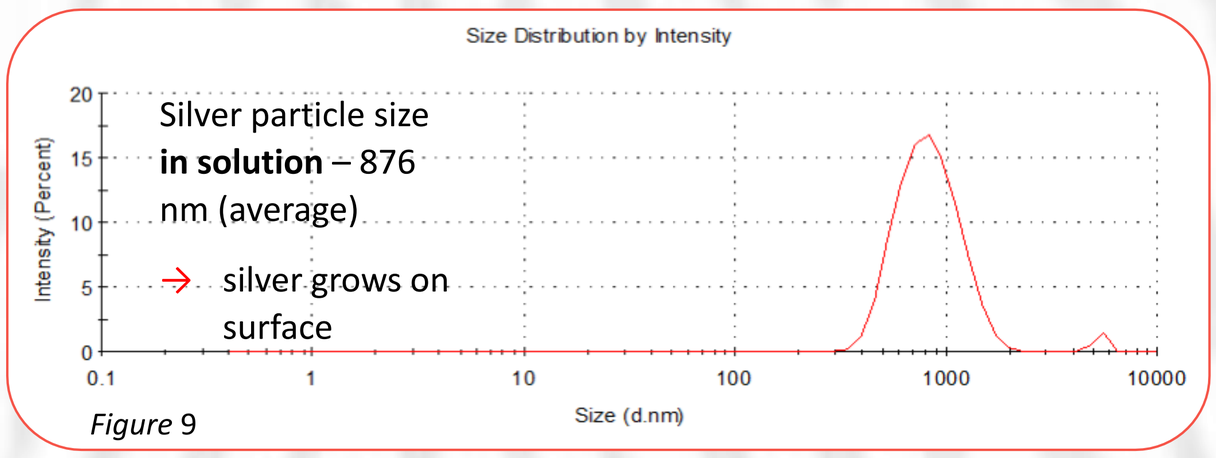

Figure 9

4. SILVER PARTICLE GROWTH

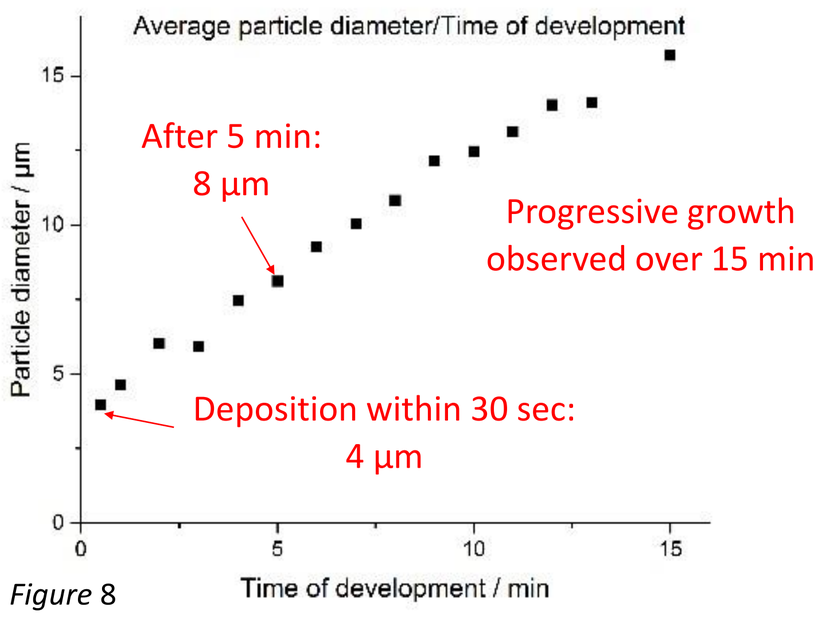

Figure 8

5. CONCLUSIONS

- Silver nanoparticles are selectively deposited onto the fingerprint residue
- Silver particles grow on the surface from 876 nm (in solution) to 20 µm
- Initial deposition of silver occurs within 30 s and progressive growth is observed
- Future work aims to explore PD for detecting fingerprints on polymer banknotes (to be circulated in the UK by autumn 2016)

References: [1] CAST, *Home Office Centre of Applied Science and Technology Fingermark Visualisation Manual* ,1st edn., 2014; [2] A. A. Cantu, *Forensic Science Review*, 2001, **13**