A7 Microwave Selective Heating in the Thermal Development of Latent Fingerprints on Porous Surfaces

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After attending this presentation, attendees will be informed about the potentialities of microwave heating technique as an innovative methodology in thermal development of latent fingerprints on porous surfaces.

This presentation will impact the forensic science community by providing application of microwave dielectric heating to the selective heat treatment of fingerprint residues on papers and other porous surfaces. Comparison with conventionally thermal developed fingerprints will be shown, highlighting the effects of peculiar characteristics of microwave dielectric heating on the visualization of fingerprints and on the obtained contrast with the surrounding porous surface.

Comparison with conventional thermal developed fingerprints will be shown, highlighting the effects of peculiar characteristics of microwave dielectric heating on the visualization of fingerprints and on the obtained contrast with the surrounding porous surface. There are several techniques which are currently used for the development of latent fingerprints on porous surfaces: optical methods and, more commonly, chemical treatment such as visualization with ninhydrin. However, there is always the need to develop new fingerprints detection techniques in order to increase the sensitivity, be readily deployed at crime scenes, be introduced in sequences of detection techniques, reduce the overall cost of fingerprint processing, and avoid the use of hazardous chemicals. Concerning all of these aspects, thermal development of latent fingerprint is of great potential since it is a simple, low-cost, and chemicals-free method. This is particularly true *in situ*ations where development might not otherwise be attempted for reasons of time and cost. It is widely recognized that thermal development of latent fingermarks on paper occurs following different stages. First, fluorescent marks are developed after rapid heating often resulting in the browning of marks which can become visible with longer heating times. Finally, fingermarks lose contrast as paper turns dark brown with further heating.

Several previous studies investigated different kinds of heating devices. Brown *et al.* performed experiments with a hot air gun, a direct contact heating method, a muffle furnace, and a GC oven. The results indicated that introducing the sample into a hot oven was the optimum technique for the thermal development of latent fingerprints on paper.[1] However, several impractical aspects of the method were evident. First, the introduction of the sample in the oven necessarily induced temperature fluctuations within the chamber that greatly influenced the degree of development of the sample. Moreover, the nature of most of the furnaces used dictated that the sample could not be monitored during treatment, making the technique difficult to execute optimally. More recently, Song *et al*. re-investigated the direct contact heating of the sample using less thermally conductive surfaces.[2] In particular, the devices investigated as a thermal developer of fingerprints on porous surfaces included a commercial hair straightener with ceramic coated surfaces, a non-stick surface sandwich toaster, and heated glass. It was determined that the hair straightener was superior to the other devices due to the high control of temperature, the high portability of the device and the speed with which samples could be treated. These advantages made it more favorable than the heated furnace. Moreover, with the hair straightener the operator could easily monitor and control the progress of the development thus reducing the risk of destroying the evidence due to overheating of the sample. However, the technique is mainly limited since it is not possible to conventionally heat the fingerprint residues and the surrounding surface to a different extent.

The goal of this presentation is to propose microwave dielectric heating as an alternative thermal treatment technique for the development of latent fingerprints on porous surfaces. As it is well known, microwave heating is fundamentally different from conventional heating since heat is generated internally by means of electromagnetic wave-material interaction. Direct coupling of microwaves with matter leads to a rapid, volumetric and selective heating of the material which is impossible to reproduce with conventional heating sources. Microwave or dielectric heating occurs by energy transfer from the electromagnetic field to the material, rather than relying on heat transfer. Dielectric and magnetic properties are the basis of the material response to the applied electromagnetic field. Particularly for dielectric materials (such as paper), the dipolar loss mechanism, due to the re-orientation of dielectric polarization, is the most prominent loss mechanism at the microwave frequencies.[3] For this reason, microwave power absorption and the consequent heating are more effective for those materials with higher water- or, better, dipoles-content. Since the main chemical constituents of the glandular secretions (both eccrine and sebaceous one) constituting the fingermarks are mostly water and minor amounts of inorganic and organic compounds, selective absorption of microwaves can lead to the thermal visualization of latent fingerprints, with the possibility of enhanced contrast with respect to conventional thermal treatments.

A specifically (for paper and wood treatment) designed microwave single mode applicator was experimentally used to develop differently aged latent fingerprints, deposited on recycled copy paper and cardboards, from different donors. Output power level of approximately 500 W was directed from the magnetron generator to the sample, which was positioned in the centre of the WR-340 waveguide resulting in visible fingerprints in less than 60 seconds. Contrast with the underlying porous surface was also obtained with the conventional thermal development techniques.

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As a matter of fact, the browning of the overall substrate was greatly reduced since the latent fingerprint residues selectively absorbed microwaves. Moreover, the overall time necessary to the visible browning of marks was decreased due to the high heating rates typical of microwave heating. The use of microwave multi-mode applicators was investigated as well, although it greatly increased the time necessary to visually detect the fingermarks. The results of all the experiments will be fully presented and the advantages, compared to the conventionally thermal developed fingerprints, will be thoroughly explained. Critical considerations concerning comparison with other development methods will be addressed during the presentation as well as the design of a dedicated and portable device.

References:

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2. Song DF, Sommerville D, Brown AG, Shimmon RG, Reedy BJ, and Tahtouh M. Thermal development of latent fingermarks on porous surfaces - Further observations and refinements. *Forensic Sci Int* 2011; 204:97-110.
3. Metaxas AC. Foundation of Electroheat - A Unified Approach, John Wiley and Sons, Chichester (U.K.), 1996.

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