A110 Discrimination of Candle Wax Materials by Gas Chromatography (GC) and Isotope Ratio Mass Spectrometry (IRMS)

Gerard J.Q. van der Peijl, PhD, and Judith Dogger, Ing, Netherlands Forensic Institute of the Netherlands Ministry of Justice, PO Box 24044, The Hague, 2490 AA, NETHERLANDS; Martin R. van Breukelen, MSc, NFI, Laan van Ypenburg 6, The Hague, NETHERLANDS; and Jeanet N. Hendrikse, MSc, Marianne A. Schrader, Ing, and Marco van Grol, Netherlands Forensic Institute of the Netherlands Ministry of Justice, PO Box 24044, The Hague, 2490 AA, NETHERLANDS*

After attending this presentation, attendees will appreciate the potential of the combination of GC, IRMS and visual techniques for candle wax investigations.

This presentation will impact the forensic community by assisting in objectively evaluating evidence provided by comparison of candle wax materials. This will assist law and court officers in correctly weighing this evidence type in arson criminal investigations and ensuing court procedures.

Candles or candle wax materials are sometimes encountered in arson investigations where they are used in devices to initiate a fire. In this situation often a request is made to compare these candle wax materials with visually similar candles retrieved during *e.g.* a search at a suspect's house. In the past, this was limited to infrared spectrometric (IR) and gas chromatography (GC) characterisation of both wax materials to be compared. If materials could not be discriminated, this was stated but no conclusion could be provided on a common source since the background variation of these characteristics was unknown to us.

In a specific Dutch high profile serial arson investigation it was deemed necessary to both use more techniques as well as obtain a measure of the background variation of the characteristics used. Techniques used at first were visual investigation (color, structure, morphology, layer thickness, hardness), X-ray fluorescence (XRF) to assess low levels of heavier elements, GC to determine aliphatic hydrocarbon profiles and fatty acid levels, GC-MS to identify additional (low-level) compounds that could be used for characterisation and Isotope Ratio Mass Spectrometry (IRMS) to determine isotope ratios of the light hydrogen (H) and carbon (C) elements of the wax samples. In this first part of the investigation it was found that the combination of visual techniques, GC and IRMS was the most informative, apparently discriminating best.

The focus in this investigation was on white or ivory colored common candles without further outside decorations such as embossing. Both tapered as well as cylindrical candles were relevant. These are sold under designations such as household, table, dinner or gothic candles. Depending on the manufacturing process as well as market preferences, candles in general consist of a white or light colored body of candle wax around the central wick and a thin outer layer that may be white or otherwise colored. One of the advantages of this combination is that a manufacturer can use a single type of candle body and cater to market demands for variation (both directly from consumers as well as from chain stores ordering batches of private label candles) by applying a variation of colored outer layers. Larger producers may in this way produce thousands of colors for their candles. This outside layer will in general have a different composition and a higher melting point than the main candle wax body. When the candle is lit, the outside layer will then melt later than the main body and act as a container for the molten wax material layer from the main body.

The differences in material composition between the main body and the outside layer in principle offer additional characteristics for discrimination. The main wax body typically will be a mixture of paraffins and saturated fatty acids, mostly stearic and palmitic acid. The outside layer almost exclusively consists of paraffins only.

In the second part of the investigation, 130 different boxes of candles were bought in a variety of consumer shops throughout the Netherlands during a short period of three weeks in February/March 2008. The main brands encountered are two different brands from a single Dutch company as well as a number of private label brands from Dutch chain stores. In addition to the direct acquisition of candle materials from the shops, manufacturers and managers at the headquarters of the chain stores were interviewed on potential handles for candle discrimination as well as on buying policies that may influence characteristics variability.

The IRMS and GC analytical methods were validated for these wax materials and candle wax composition variation was determined, both along the length of single candles, within candle boxes and in between candle boxes from a single brand. Apart from the variation in candle wax composition also visual characteristics were determined and it was recognized that candles had been produced using a number of different industrial candle manufacturing processes (extrusion, drawing, molding). The drawing process results in a typical layered structure (tree ring effect) of the candle cross section and in the extruded candle visual inhomogeneities may be observed reflecting the granular nature of the extruder feed.

From the IRMS and GC analytical results it was observed that variation was highest in between brands. For boxes of a single brand, inter box variation was much higher for private label brands than for the main single brand producers. These results reflect buying policies of chain stores for their private label

 ** Presenting Author*

brands. A few manufacturers are selected for a single private label brand to encourage competition and otherwise selected batches of candles may be acquired from other manufacturers.

IRMS, Candle, Arson

 ** Presenting Author*