

THERMAL ANALYSIS IN FORENSIC SCIENCE

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ABSTRACT

A review of the uses of thermoanalytical methods in forensic science is presented. Applications include studies on: the thermal behaviour of human hair, skin and finger nails, the DTA, DSC, TMA and thermomicroscopic characterization of polymers and fibers, DTA and TG of food grains, DTA of explosives, DTA, TG, DTG of glass, rubber, paint and plastics parts from vehicles and of soils from shoes, clothes, appliances, cars.

Nowadays Police Forces rely more and more on hi-technology analytical methods in order to acquire objective evidence to be used in Courts. Neutron activation analysis, microprobes, mass spectrometry, scanning electron microscopy, gas chromatography/MS are used for the characterization and comparison of organic and inorganic materials related to criminal acts.

Thermoanalytical methods, mainly DTA, TG, DTG, DSC, but also TMA and thermomicroscopy have been employed with success for examining dynamic thermal properties of important evidential cases. From the Author's work in 15 years of collaboration with Italian Courts and from the literature, examples of applications of these methods to forensic problems are reported.

Parts of the human body have different thermal behaviour depending on race, age and sex. Lorant (1) reports TG/DTG data for human skin. Analyses of human hair made by Scwenker and Dusenbury (2) and Basu and Marjit (3) and recent data obtained by the Author show encouraging results. Marjit (4) evidenced clear differences among the DTA-TG-DTG curves of finger nails from men and women of different age groups.

DTA, DSC and TG-MS have been considered by forensic scientists for the characterization of polymers and fibers (5,6) and also for investigations on their fire resistance (7). Synthetic fibers encountered in forensic science cases were studied and differentiated by thermomicroscopy (8). A review of the utility of TMA for the examination of synthetic polymers was published in the Journal of Forensic Science (9). DSC has been used for the analysis of drugs, asphalts, oils, waxes and DTA-TG for the characterization of food

grains (10). DTA has been employed in the study of the heats of explosion of nitrocellulose firearm propellants obtained from reloading powders, factory ammunition, test-fire targets (11).

Various materials from cars involved in criminal offences may be successfully examined by thermoanalytical methods. F.e. in hit-and-run cases, an analysis of the debris left on the site of the accident may lead to a quite accurate picture of the offending vehicle. High-temperature-DTA-TG can characterize the glass from a broken headlamp. DSC, DTA, TG of debris of plastics, rubber and rubber-like parts (such as from tyres, bumpers, traffic indicators, covers, linings) can help to recognize the type of offending car. Backledge (12) reports on the results of an exam of rubber bumper guards by pyrolysis-gas chromatography.

Original automotive topcoat and other layers of paint, primers and repaints are being used to identify manufacturer, vehicle line, vehicle series, model year, assembly plant of offending hit-and-run vehicles (13). Infrared spectroscopy is one of the most widely used analytical methods, but there are also examples of successful applications of pyrolysis-gas chromatography (14, 15, 16) and laser beam emission spectroscopy (17). Stocklein and Helmiss (18) and Marjit (10,19) evidenced by DTA-TG-DTG and DSC differences among paint chips related also to ageing processes.

DTA, TG and DSC of the rubber left on the road by sudden accelerating or braking can be used to trace back the type of tyres and therefore narrow the range of offending vehicles. A comparison with the rubber from the tyres of a suspect's car can prove a very valuable objective evidence. A file of DSC curves of rubber from different brands of tyres was prepared by a major tyre-producing company for use by Police Forces.

The mixture of organic and inorganic components of a soil gives an unlimited number of compositional varieties and of their thermal curves. Analysis of "dirt" from shoes, clothes, tools, appliances, means of transport of a suspect may relate the area of the criminal offence to his whereabouts (20, 21). The provenance of a car abandoned after a criminal act may be traced studying the incrustations under the fenders and of the body or of the dirt on the windscreen or on the floor and boot. Soil from the lungs of a drowned may help to locate the place of drowning and exclude death before the body was immersed in water.

Beyond their scientific value, thermoanalytical methods provide comparative graphic presentations which can be understood and evaluated also by the non-specialists, such as Police Officers, members of Courts and Lawyers.

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