B114 The Reconstruction of Obliterated Serial Numbers in Polymers Using Raman Spectroscopy

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Learning Overview: The goal of this presentation is to increase awareness about the existing and the potential non-destructive methods for reconstructing obliterated serial numbers in polymers by touching on acquisition times, system requirements, and detection limits.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by offering a new, promising technique that may allow for this analysis by portable spectrometers, leading to feasible deployment to multiple forensic laboratories and possibly police services.

Forensic practitioners (e.g., ballistic experts) commonly encounter restoration cases of serial numbers, as they provide valuable information for investigative purposes (i.e., identification or individualization of a given object). These numbers are often introduced by stamping techniques. However, criminal activity generally leads to tampering of their depth profile by abrasion in order to prevent reading.

Although some reconstruction techniques already exist in literature for these specific types of materials, they are not effective and are most of all destructive (e.g., require the use of strong acids). Therefore, they are problematic when dealing with a sample that may be the subject of a criminal investigation or trial. In the absence of an efficient and reproducible recovery method, the research group has established a non-destructive laser scanning microscopy scheme to exploit the vibrational Raman spectrum of polymers in order to image strain on different length scales.

This technique, based on the inelastic scattering of photons and optical phonons, has enabled the exploitation of the variations of the peak shift, full width at half maximum (phonon lifetime and local ordering of the material), peak intensity ratio, as well as the correlation of these independent signals.[1,2] As they provide information on the vibration modes of a given molecular bond, these signals can be used to create contrast when imaging a sample that has sustained partial strain (e.g., impression depth of 150µm with a strain depth profile of 750–800µm), despite being obliterated (e.g., obliteration depth of 200µm).

Additionally, recent efforts have been focused on a new signal, the local depolarization ratio. It is defined as the intensity ratio of the spectral band measured, respectively, along the perpendicular and the parallel axis in regard to the direction of polarization of the incident beam. As this ratio provides information on the particular symmetry of vibration modes, it can potentially be used as an imaging tool with promising results in regard to faster acquisition times and data treatment as well as reduced system requirements.

Reference(s):

1. Parisien Cédric, Gitanjali Kolhatkar, Frank Crispino, André Lajeunesse and Andreas Ruediger. Reconstruction of Obliterated Characters in Polycarbonate through Spectral Imaging. *Analytical Chemistry* 89 (2017): 11648-11652. https://doi.org/10.1021/acs.analchem.7b03069.
2. Parisien Cédric, Gitanjali Kolhatkar, Andreas Dörfler, Frank Crispino, André Lajeunesse and Andreas Ruediger. Contrast Enhancement for the Recovery of Obliterated Serial Numbers in Different Polymers by Correlated Raman Imaging of Strain, Phonon Lifetime, and Strain-Induced Anisotropy. *Analytical Chemistry* 91 (2019): 14247- 14253. https://doi.org/10.1021/acs.analchem.9b01621.

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