B158 The Use of Optical Profilometry to Characterize Fabric Impressions in Vehicle Surfaces

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Learning Overview: After attending this presentation, attendees will better understand the connection between visualization, impact force, and depth measurements of three-dimensional fabric impressions in vehicle surfaces.

Impact on the Forensic Science Community: This study will impact the forensic science community by providing criminalists with an additional investigative and reconstructive aid for vehicle-pedestrian collisions.

Vehicle-pedestrian collisions often result in two-way transfers, in which physical evidence is transferred from the vehicle to the victim and vice versa. Transfers often include biological matter, textile material, and fragments of various automotive components, such as paint, glass, and other synthetic materials. Another form of evidence that may be present is impression evidence from the vehicle's tires, either at the scene or on the victim; additionally, fabric impressions may be formed in the vehicle's paint or other components. Upon impact with sufficient force, the structure of the fabric from the victim's clothing can be impressed in the automotive finish, resulting in a three-dimensional (3D) imprint. While the primary focus of forensic investigations of vehicle-pedestrian incidents heavily relies on the association of transfer evidence between victim and suspect vehicle, 3D fabric impressions could provide criminalists with an additional investigative tool. Several factors, including impact force, composition and construction of fabric, and the physicochemical composition of the automotive finish, likely play an important role in the formation of fabric impressions in vehicle surfaces. The goal of this project is to further investigate these factors and better characterize the formation of fabric impressions.

Impressions were generated using a large-scale pendulum impact device located at the Pennsylvania State University College of Engineering Civil Infrastructure Testing and Evaluation Laboratory (CITEL). The pendulum was equipped with a 6-foot long quick release arm mounted a in 9-foot frame; a weld cap attached to the arm served as a simulated knee. The simulated knee was covered with a piece of denim fabric from Levi's 550™ jeans over a layer of ½-inch thick foam. Samples that were impacted were collected from known vehicle hoods, trunks, doors, and body panels. These vehicle samples were cut to approximately 5 inches by 5 inches and secured into a sample holder with a ¼-inch thick steel backing plate. The pendulum arm height was adjusted to alter impact height thereby varying impact force. While the textile material and vehicle test substrate were held constant, impact height was adjusted to produce fabric impressions of varying visibility and depth.

This study utilized a Zygo® Nexview™ 3D Optical Profilometer, a noncontact and nondestructive instrument. The optical profiler was used to conduct vertical and lateral scans of the impacted surfaces, producing three-dimensional surface topography images of the substrate. This permitted visualization of fabric impressions on a micro-scale and the ability to quantitatively measure impression depth. Preliminary scans of fabric impressions using the optical profilometer showed an increase in the visibility of fabric impressions as impact height increased. If better understood and characterized, fabric impression evidence could serve as an additional aid in the investigation of vehicle-pedestrian collisions.

Vehicle-Pedestrian Collision, Fabric Impression, Optical Profilometry