



A200 The Forensic Assessment of HID (Xenon) Headlights: Determining Energization State and Identifying Illegal Vehicle Modifications

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After attending this presentation, attendees will have a basic understanding of the construction and operation of HID headlights, have a tentative method of determining the on/off state of HID headlights prior to vehicular impact, and be able to identify illegal vehicle modifications.

This presentation will impact the forensic science community by breaking new ground on a little touched aspect of vehicle forensics. The knowledge to be presented will allow analysts to address two investigative questions in the course of one analysis.

Methods for determining on/off state of halogen headlights from vehicles involved in accidents are well established and are used often. However, for the last fifteen years these lights have slowly been phased out in favor of newer high intensity discharge (HID or Xenon) headlights. No known method yet exists to determine on/off state of HID lights from vehicles involved in crashes. As the number of HID equipped road vehicles continues to increase, this gap in knowledge needs to be filled. Furthermore, the popularity of HID lights has fostered the development of an entire underground industry dealing in illegal HID retrofits. These illegal retrofits violate federal rules, however enforcement of said rules is sparse at best.

The purpose of this research is twofold: (1) analyst should be able to recognize what aspects of the various functional components of HID lights vary in crashes dependant upon energization state, thereby allowing one to determine if the headlights were on or off at impact; and, (2) analysts should be able to distinguish HID light configurations common to illegal retrofitting from HID lights common to legally equipped vehicles. Together, these will allow analysts to address two important investigative questions in the course of one analysis.

For the experiment, several high intensity discharge headlight bulbs were destroyed in a manner approximating vehicle impact events; being destroyed in energized and non-energized states. The glass, electrodes, halide salts, and lead connectors were then analyzed with stereomicroscopy with application of UV light & SEM/EDX to determine what aspects of each vary dependant upon hot or cold breakage. Of all aspects observed, oxidation of electrodes and dispersal of halide salts secondary to inner chamber rupture are best for distinguishing an energized lamp from a non-energized lamp. Lamps broken while off/cold showed no oxidation of the electrodes and the salts remained affixed as an amalgam to the lower eighth of the inner chamber. Application of EDX confirmed oxidation/non-oxidation of electrodes. UV light application to the salts can also confirm hot/cold break determinations, as salts exposed to air after a cold break will fluoresce at 350 nm whereas salts exposed while hot do not. Furthermore, signs of electrical arcing of the lead connectors were present if an energized lamp was broken along that part of the bulb's axis.

The inner chamber and outer shield glasses could be separated from each other with a UV light when fragments of each were mixed together. The idea being tested was that the inner glass experiences more extreme temperature variation than outer shield glass and that a large temperature difference could manifest in the form of unique fracture morphologies. Analysis of hot and cold break inner chamber glass under SEM, however, did not reveal any significant differences.

Evaluation of illegal vs. legal HID lights was conducted by researching legal manufacturing practices and applications of HID's in the car market. This included technical specifications of legal lights and on what vehicle models HID's are normally equipped. Then, online exploration of illegal retrofit retailers, purchase and examination of their lights, and research into instances of federal enforcement of violations was conducted.

Legal lights are characterized by being available in only two configurations, with lights being made after 2007 additionally being mercury free. Illegal lights from retrofits are characterized by having a multitude of configurations mimicking those of the halogen lights they are meant to replace. Furthermore, EDX analysis confirmed the presence of mercury in retrofit lights. In regards to enforcement of federal rules, only one instance in 2003 appears in the last decade.

The results obtained from this preliminary research have led to the development of a method to tentatively determine if a HID light was on or off at impact. It also presents a way to distinguish legal lights from illegal lights. Though further research is needed, the first steps in a new direction have been taken.

Xenon, Headlight, Filament