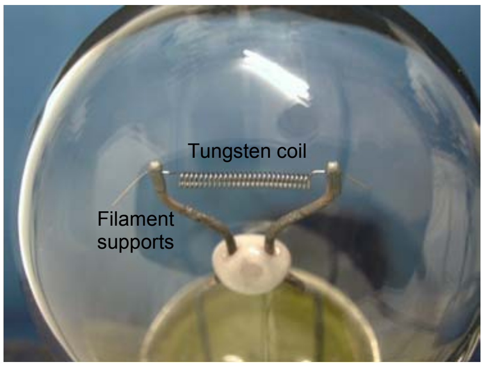
Forensic Light Bulb Examinations

The most obvious application of lamp examinations is motor vehicle crash investigations were it is often necessary to determine whether a vehicle has been appropriately illuminated, especially if the accident is serious. This article will focus on road traffic accident applications, and will give an over view of the types of bulb failures commonly seen and how these relate to crash scenarios.

It is first important to understand how lamps function: the majority in use have single or dual coiled tungsten filaments suspended on a metallic support. Current passes through the filament which then becomes hot and emits light in the visible spectrum. The filament is protected by the glass bulb which contains an inert gas to prevent oxidation of the coil.



Undamaged lamp showing evenly spaced, undeformed coil

There are other types of lamp including LED clusters, but we will not concentrate on these.

Lamp features

The condition of the filament and glass can indicate the events in the lamp's history allowing investigators to estimate its age, and sometimes even the direction of impact. The following features are common in examinations:

Filament coil deformation
When a coil is incandescent, the tungsten coil becomes ductile and so if the bulb experiences a strong impact, the coil may deform. The spacing of the coil turns changes as the filament distends; this is also indicative of filament temperature.

Where there is more than one filament in the lamp (for example dip and full beam headlamps), the deformation of the coils will either be of a similar magnitude or one coil may be more heavily distorted than the other. In the latter case, it is likely that one filament is incandescent and heats the other. The filament that deforms the greatest will usually be the coil that was illuminated; however other factors such as the wire gauge must be taken into account, and so this is only a guide.

Dual filament brake/tail lamp. The finer tail filament was not incandescent, but was heated by the lit brake coil.

Coil oxidation
If the bulb is broken, the filament will contact air as the inert gas escapes, and if the coil is hot, the tungsten will oxidise. If the coil is hot yet not incandescent, the tungsten may appear tinted with colours ranging from straw to greens and purples, however if the lamp was lit, the oxides are mostly black, in addition 'oxide smoke' may form which is deposited on adjacent sufaces. An extreme example of this is shown in the image below.

Filament heated by neighbouring coil. Note the tinting.

Heavy oxidation caused by exposure to air whilst incandescent

Coil fracture
Coils may break whilst hot or cold. If a coil is neither conducting nor adjacent to a heat source, it will be brittle, and may fail by brittle fast failure in the event of a collision. This is typified by bright, evenly spaced coils and if often termed “cold shock”. Ductile filaments will sometimes demonstrate necking and will not show the same uniformity as the example below.

Cold fracture of a filament coil.

Summary

Bulb investigation is rarely as clear cut as this might suggest, it is often a case of drawing on extensive experience and weighing up several features of the lamp. Filaments can sag with age or may be arched during manufacture leading to misdiagnosis of a hot shock failure; blackened bulbs can be misinterpreted as having been blackened by oxidation. Caution must be exercised when stating certainty in any result, especially when apportioning blame and it is very important to realise that any damage may not have been caused by the accident in question but could have been the result of a previous incident. However in saying this, forensic lamp examination can prove valuable in RTA and other failure investigations.

Helen Thorneycroft
DRB Materials Technology Ltd
www.drb-mattech.co.uk