Reflecting on road runners and other nocturnal creatures

illumiNITE

High visibility footwear has come a long way from the days when the locals of some South American countries and the West Indies tied brightly blinking Cucuyo fireflies to their boots to light their way along night-time paths. Both on city streets and country roads, where cyclists and runners share the asphalt with automation, retroreflection and lights have become a standard feature on footwear, as they have with other articles of active sportswear. Be safe – be seen, your life may depend on it. After dusk, walkers, runners and cyclists need to take extra care that vehicles see them clearly as well as seeing where they are going themselves.

Sports lights as an attachment or component for running shoes have been around since Lotto first introduced them in 1983. However, flashing lights, despite their obvious safety feature of being highly visible at night, have never really caught on with runners and walkers. The Italian company placed a flashing light at the back of the shoe as a battery-operated attachment to the heel counter. At first, this functional alternative to retroreflective trim on shoes seemed practical and highly visible. However, when an innovative, fully integrated, LED flashing light system was introduced by L.A. Gear in the 1980s in the mid-sole, it was immediately commercialised as a children's fun shoe gimmick and quickly lost credibility as a safety feature amongst serious outdoor sports enthusiasts. Companies such as Bright Gear-Supernova still produce multi-coloured attachable flashing lights that can be clipped onto shoes, wristbands and caps etc., but whether it's a balance issue or simply too obtrusive for the average runner, flashing lights have been largely confined to children's footwear as a novelty item.

Much preferred by active nocturnal athletes are the built-in reflective trims and patches produced from 3M Scotchlite material and others known as retroreflection. Retroreflection helps the eye to perceive light in low-light conditions. In more scientific terms, retroreflection occurs when light rays are returned in the direction from which they came. A large amount of reflected light is returned directly to the original light source, such as a car's headlights. Since very little light is scattered when the light is returned, retroreflective materials appear brightest to an observer located near the original light source.

There are two major types of retroreflective materials available on the market today – glass bead and microprism. The ANSI/ISEA 107 standard recognises 2 levels of retroreflective material performance; level 1, with a minimum co-effeicient of retroreflection at 0.2° observation and 5° entrance angles (commonly referred to as 'head-on brightness') of 250 cd/lx/m2 and level 2 with a minimum head-on brightness of 300. In a glass bead system light strikes the back surface of the bead and is returned to its source. In contrast, light strikes each of the three surfaces of a microprism in turn, before returning to its source. Comparing equal factors such as placement, amount and movement of the reflective material on the garment, microprism technology tends to provide more reflective surface area than glass beads in comparative testing. However, the amount and placement of retroreflective material used (360° visibility and defining the human form, i.e. arms and legs) are more likely to be significant factors in providing adequate visibility. 3M makes both retroreflective glass bead and microprisms and tests both technologies to meet and exceed the highest standards of reflection.

In Reflexite technology, with its head office in Avon, Connecticut, retroreflective efficiency is enhanced by the precise arrangement of the microprisms, as seen in a microscopic view. Glass bead material is less expensive than microprism but tends to be susceptible to abrasion, whereas microprismatic materials, in addition to having brighter characteristics, can better withstand abrasive conditions. Comparing random size and placement of the glass beads with the precise uniformity of the Reflexite microprism array, the microprism's economical use of surface area delivers the highest standard of reflection.

Lightweight Momentum MicroWeave jacket from illumiNITE comparing day and night visibility.

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Standards in the US

In 1999, the American National Standards Institute (ANSI) and the Safety Equipment Association developed a new standard for High-Visibility Safety Apparel, (ANSI / ISEA 107-1999) that addressed this issue, in microscopic detail. The seventeen pages of text describe garment construction and performance standards. There is an Appendix that assigns garments into one of three conspicuity classes. The classes, that include footwear, address elements such as:

- Wearer tasking and likely distractions
- Proximity to traffic
- Traffic speed
- Square inches of fluorescent background fabric of the garment and the amount (and placement) of retroreflective trim.

The level of the wearer's exposure and tasking determines garment type. Basically, the standard says: the faster the traffic, the more conspicuous the wearer should be. Night-time / low light exposures include use of retroreflective materials incorporated into the apparel.

In September 2004, ANSI approved a revised edition of the standard, ANSI/ISEA 107-2004. This was the culmination of several years of work by ISEA High Visibility Products Group, in cooperation with employers and workers, test labs and material suppliers, safety professionals, and federal, state and local authorities. The revised version, which previously included vests, jackets, bib/jumpsuit coveralls, trousers and harnesses, now expanded the product coverage to include high-visibility headwear—a fairly important item for the athlete-in-the-dark.

The new revised standards retain the established three Performance Classes for high-visibility safety apparel and doesn't change the basic requirements of the standard such as garment dimensions, colour or retroreflective performance, with the exception of clearly prohibiting any kind of sleeveless garments to be labelled Class 3 when worn alone. To comply with ANSI/ISEA 107-2004, a shoe or garment's background material, and retroreflective or combined performance material, must be tested and certified by an independent, accredited third-party laboratory. The manufacturer of the finished item then verifies that the shoes, garment or headwear meets all the requirements of the standard, and provides a certificate of compliance for each model.

Among the new specifications are:

- Fabric conspicuity requirements for low light, daylight and complex visual backgrounds.
- Minimum square inches of materials, including retroreflective material.
- Fabric colour-fastness, fade and abrasion resistance.
- Garment design, coloration, mechanical properties, water penetration, etc.

Examples of new high visibility garments include vests, jackets, shirts, pants and coveralls. Fluorescent and background contrasting fabrics are recommended for certain exposures. Night-time and low light (dawn, dusk, interior exposures) require close attention to retroreflective trimming and pattern, also specified in the new standard.

illumiNITE, based in Cheshire, UK, is a well-known name in the outdoor sport clothing market in recent years. Its patented technology combines high tech fabrics with reflective properties to offer enhanced safety night-time activities. These are high quality traditional garments with the unique feature of being highly silhouette reflective in a way that highlights a distinctive, recognisable profile of the human body, especially of aerobic area of the body in motion such as arms and legs. It could be seen as a full head to toe visibility solution. A subtle cross-hatch pattern on the surface of the garment fabric during the day, the illumiNITE matrix bounces light, oncoming headlights for instance, back to the source at night. This technology stands out from the background in situations that might not be appropriate for a reflective vest.

Its consumer products are not currently specified to meet any prevailing ANSI or other similar standards. However, several of its occupational safety products, widely used in law enforcement, fire rescue and uniform applications, do meet ANSI standards using a unique combination of illumiNITE and custom reflective trims and appliqués.

Application methods

Retroreflective technology can be applied in several forms, either as beaded glass or microprism applications. The following description explains how retroreflective products are manufactured into reflective products for end use.

- Transfer Films are composed of retroreflective lenses bonded to a variety of heat-activated adhesives. They are ideal for conversion into emblems, patches, logos and labels in a variety of shapes, sizes, numbers and letters, and are often used to make continuous laminated trims and piping. Transfer films may be die-cut, hand-cut or guillotined. They may be heat laminated to fabrics or backings using a heat press, roll-to-roll laminator, heat fusing machine or radio/high frequency (RF or HF) welding equipment. Transfer films may also be screen printed (usually after lamination).

- Fabrics are composed of retroreflective lenses bonded to a variety of fabric backings. They sew easily onto other fabrics and can be embroidered or screen printed for patches and emblems. Fabrics may be hand-cut, die-cut, slit or guillotined.
- High Gloss Materials are composed of microprisms bonded to a flexible, glossy, UV-stabilised polymeric film. They are available from 3M Scotchlite™ material either sealed to a vinyl backing or unsealed for custom converting. They may be sewn or radio/high frequency (RF or HF) welded to compatible fabrics. High gloss films may also be screen printed, embossed or used as piping.
- Pressure-sensitive adhesive (PSA) Films are composed of retroreflective lenses bonded to a variety of PSA. They are easy to apply to rigid substrates – simply peel and stick. PSA films may be hand-cut, die-cut or kiss-cut, and may be screen printed. Permanent adhesion to washable garments, however, is not recommended.
- Graphic Transfers are made by screen printing an adhesive in reverse print onto the back side of a sheet of retroreflective lenses. The printed transfer is then heat laminated directly to fabric. Non-reflective colours can also be combined with the transfer for added design capabilities.
- Inks are composed of a water-based (latex) ink base combined with retroreflective lenses. They are used for direct screen printing onto fabric for decorative, reflective images.
- Reflective Tyre Sheeting and Vulcanisable Film are composed of flexible, durable, exposed lens retroreflective sheeting designed for vulcanisation to compatible non-staining natural rubber compounds. Typical applications include tyres (bicycle, truck etc.) and footwear (boots, running shoes, etc.).
- SOLAS grade products are composed of an encapsulated incorporated onto two types of backing: sewable and PSA. They perform well whether wet or dry and enhance the visibility of life support equipment such as life vests, jackets, rafts and other fabrics.
- Yarns are composed of retroreflective beads bonded to film or fabric and slit to very narrow widths. Reflective yarn may be woven directly into ribbon, trim, piping, laces, cords and fabrics to achieve a wide range of reflective patterns.

Many of the above materials are made in several high-visibility colours such as, white silver, orange, red, blue and fluorescent lime, pink, yellow and green.

Retro-reflective materials, either bonded or stiched on, or woven into, sports apparel give added visibility to enthusiasts of a growing number of outdoor sports.

3M

The more exposed retroreflective surfaces are visible on a garment the more protection is afforded the wearer. Typically, in warmer weather conditions runners are likely to wear only a vest, shorts, socks and shoes on an evening training session. Shoes may not have as many square inches of exposed retroreflective surface as other garments but they are highly visible due to the speed and area of movement of 'running feet'. Very early in the 'biomechanical' era of footwear innovation, when function took precedence over cosmetics, reflective trims quickly became a safety selling feature on better grade running shoes. Initially, retroreflective trims were sewn into the counter pocket area of the shoe as an underlay. 3M Scotchlite™ materials was the first material used by dedicated running shoe companies such as New Balance, Brooks and Saucony. As new materials, coatings and applications became available it became possible to incorporated more reflective material on different parts of the shoe such as on the quarters and vamp. Laces are made are made by Bright Gear–Supernova with retroreflective threads and high density exoskeletal shank and external heel counters can be coated with reflective transfers and film.

Currently, retroreflective materials in their various forms can be incorporated into almost any outdoor garment or shoe, including the Beacon Bootie from illumiNITE, which is a Comfortec stretch/Lycra laminated shoe cover highly visible at night. Listed below are some of the popular apparel items incorporating retroreflective materials used for night visibility in both work and recreational conditions.

- On shoes as reflective trims, films, transfers, laces and threads on various parts of the shoe.
- Reflective Vest – mesh/nylon sleeveless vest, slip on variety for night walking with reflective strips on front and back provides night safety, and you can get them in orange for higher visibility during the day.
- Runner's Vests – lightweight tank top vest with reflective strips sewn horizontally around the chest.
- Reflective Socks.
- Full Jacket – for men and women. Looks like a normal garment but has reflective threads throughout, giving the wearer 360-degrees of high-visibility safety.
- Pants, Shorts and Tights.
- Reflective Caps and Hats – reflective stripes are sewn or high-frequency welded onto caps and hats.
- Hi-Viz Gloves for road and construction workers are made in reflective yellow.

With today's level of retroreflective technology and the variety of clothing and footwear incorporating high-visibility apparel, there's no excuse for putting yourself at risk at work or play after the sun goes down. From head to toe retroreflective wear has got you covered - safely.