Switching from opaque to transparent

Managing near infrared light using visibly opaque materials

Donald Tibbitt

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Fig. 1 Multiple smart car functionalities rely on photonics

Near infrared (NIR) light is becoming pervasive within products to improve perception, functionality, and safety. NIR is used in applications ranging from lidar and automotive ADAS to machine vision systems, night vision cameras, IR remotes, touch screens, and various medical and therapeutic uses.

NIR illumination and detection electronics often incorporate a protective cover or lens that appears black or visibly opaque. The black cover on the end of a TV remote or a dome around a night vision security camera are examples of visibly opaque but NIR transmitting materials. They obscure electronics and reduce heat from the solar visual spectrum while efficiently transmitting the NIR portion of light. They also expand design options and minimize the appearance of welds created by NIR lasers in part joining operations.

NIR light, traditionally classified as starting at 780 nm, has several advantages over visual light, such as no glare, lower diffraction under problematic atmospheric conditions, and increased transmission through many materials compared to visible light. Another advantage is that NIR wavelengths were largely presumed to be invisible to human sight as human eye sensitivity dramatically decreases at wavelengths longer than 700 nm.

More recent studies indicate that some human eyes can detect a visible

Company

Epolin

Since 1983, Epolin has produced the highest quality materials to meet laser protective eyewear manufacturer needs, with Epolight dyes and Luminate thermoplastic pellets. Epolin develops and manufactures near-infrared absorbing dyes and thermoplastic compounds. Our materials provide premium performance for laser and welding eyewear, light filters, touchscreens, night vision products, sensors, lidar, and security inks.
Epolin is a subsidiary of the Chroma Color Corporation, and manufactures and ships products from our headquarters in Newark, New Jersey, USA. Epolin regional distributors include AAKO BV (Europe), SN Consultant (Japan), and Sun & Bright Industrial Ltd (China).

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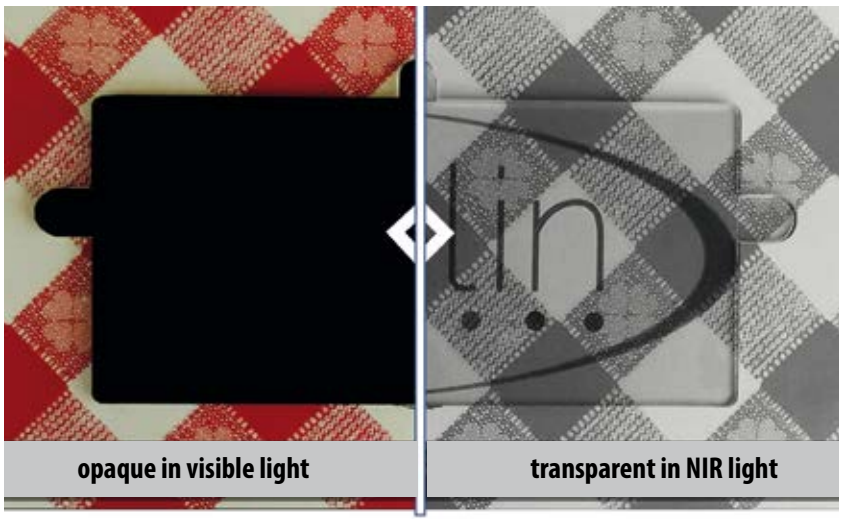

Fig. 2 Materials can exhibit different behaviors depending on wavelength

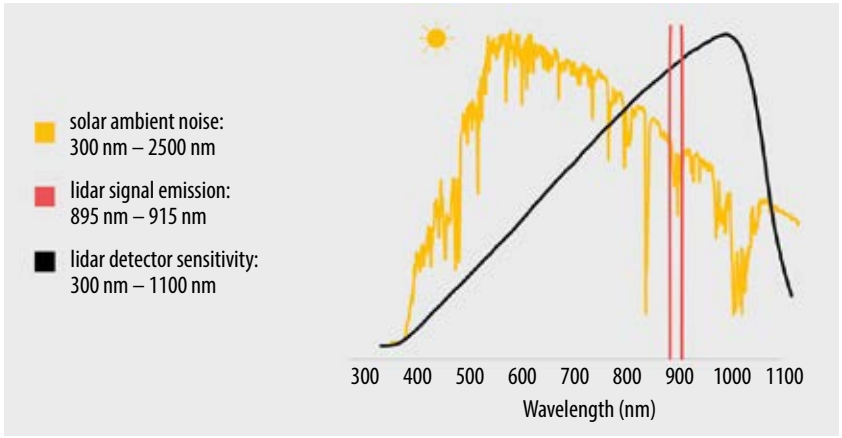

Fig. 3 The lidar filtering challenge, resulting from ambient light and detector sensitivity

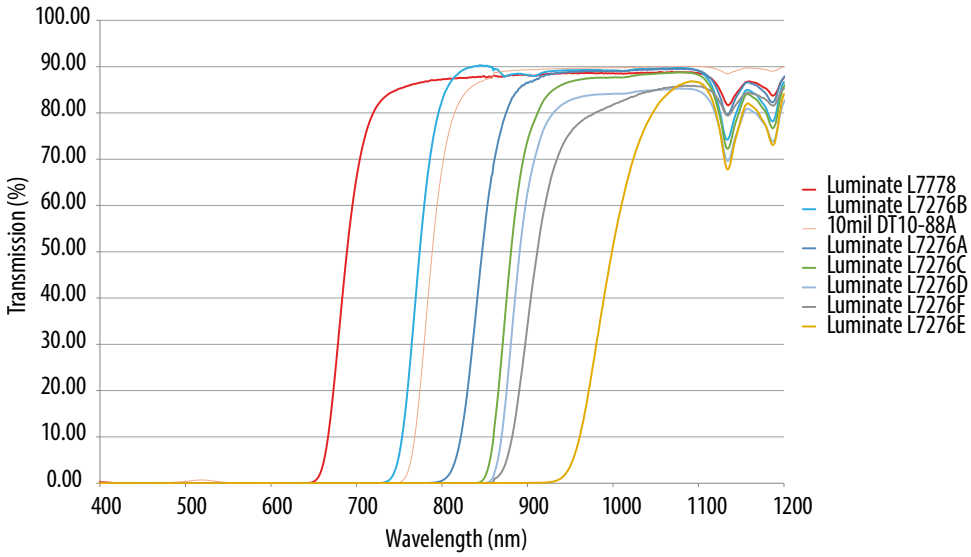

Fig. 4 Transmission spectra of Luminate formulated thermoplastic pellet grades

light response from the NIR light above 780 nm. One study demonstrated that the human eye may respond to radiation up as far as 1,064 nm depending on the light intensity, duration, angle, location of the image on the retina, as well as other factors. As NIR light applications have expanded, international standards have been established to limit infrared exposure to the eye. IEC-62471 covers LEDs, while lasers are covered by IEC-60825.2.

Sensors, like human eyes, are also susceptible to environmental factors that can reduce performance. Fortunately, visibly opaque materials can be utilized to pass desired signals while rejecting noise or interference.

Lidar-functional visible opaque applications

Lidar is often used as a highly capable environmental mapping technology, enabling higher levels of vehicle autonomy. Lidar units produce a narrow band of 905 ± 10 nm NIR light that reflects off illuminated objects and returns to the detector in the unit. If the detector receives a clean return signal, it produces a highly accurate positional map of the environment based on those reflections.

A typical silicon-based lidar detector chip is highly sensitive around the narrow lidar signal range, but is also sensitive to shorter NIR and visible wavelengths. Ambient sunlight reaching the earth's surface contains a wide range of UV, visible, and NIR light which, combined with interference from other NIR sources like LEDs or other lasers, can saturate the lidar detector, thereby reducing overall system performance.

Using visible opaque materials formulated with specific NIR absorbers effectively filters both visual and NIR noise that lies outside of the targeted lidar signal band. Such light management techniques can dramatically improve lidar resolution and range.

Interior ADAS visible opaque applications

Beyond exterior applications, in-vehicle ADAS applications including driver alertness and occupant sensing applications increasingly rely upon NIR light management (Fig. 1). Such applications use NIR LEDs to illuminate objects via directed or flood lighting of the cabin. Some occupants may perceive such emissions once their eyes have adjusted to low visible light conditions while driving at night. Visible opaque formulations tailored around specific illumination spectra can mitigate potential occupant distraction. As facial and gesture recognition systems evolve, Epolin can customize light management solutions, whether they are based on LED or laser technology.

Product options

These visibly opaque, NIR transmitting functional materials (comparis on Fig. 4) may be sourced as an Epolight dye blend

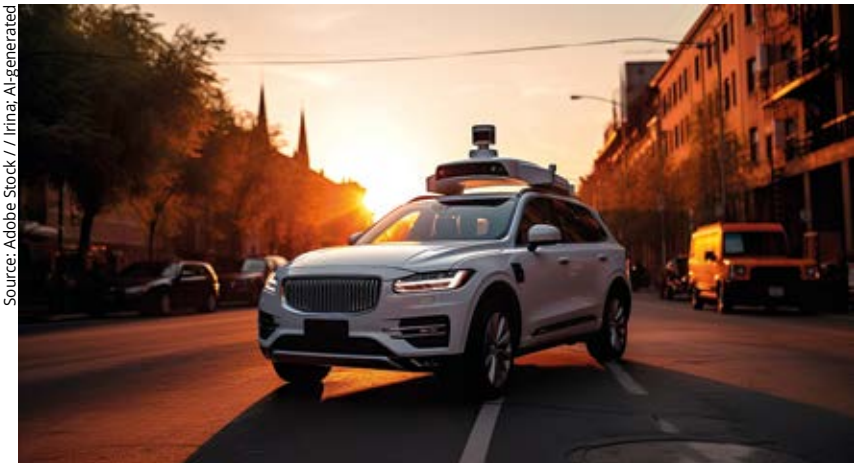

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Fig. 5 Lidar systems need to be protected from interference to ensure full functionality at all times.

in powder form for compounding or as ready-to-mold Luminate compounded thermoplastic pellets. Ink or thin film supply forms are also available.

L7778: An economic solution to obscure device electronics like IR remotes.

L7276B: Produces a deep, aesthetically appealing black that can be formulated into various shades of grey. Suitable for NIR laser welding and joining operations.

L7276A: Used to reduce solar and NIR interference and improve 905 nm lidar signal fidelity. Reduces red glow from 850 nm illumination in security camera applications. High transmission above 880 nm.

L7276F: Mitigates the red glow from 940 nm LEDs for applications requiring covert illumination concealment.

L7276E: Begins to transmit above 950 nm with good transmission over 1,050 nm.

Epolin's technical team can provide timely, optimized, product recommendations for your specific application. Should a novel approach be required, the company's R&D group has the capacities to develop new materials targeted to a customer's unique specifications. Epolin's 'concierge chemistry' approach to product development and light management expertise allows the company to address a wide range of challenging opportunities.

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Donald Tibbitt is an organic chemist with over twenty years of experience in synthesizing, formulating, and compounding UV, visible, and infrared dyes. After holding positions at Dupont and AstraZeneca, he joined Epolin where he serves as technical marketing director. Epolin is a global leader in optimizing near-infrared and visible light transmittance in plastic parts, films, adhesives, and coatings.

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