

DAYLIGHT FLUORESCENT COLOR - THE COLOR THAT SHOUTS

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Daylight fluorescent colors have a long history of use for virtually dozens of safety related applications. The claim to fame for these uniquely different colors is extremely high brightness in the presence of daylight (up to four times brighter than regular colors).

Most scientists, engineers and consultants who design and/or specify products and materials for safety purposes have a broad awareness of these bright colors and some of their more common uses such as traffic cones, flagmen's vests and warning flags. What is not generally understood is the phenomenon that is responsible for these high intensity color effects. A basic knowledge of this mechanism will also explain why the functionality of daylight fluorescent colors increases several times in dawn, dusk, fog and overcast conditions.

The objective of this presentation is to give a layman's definition for the phenomenon and a brief history of successful uses of daylight fluorescent colors in safety products and applications.

An understanding of the "why and what" of fluorescent color will facilitate judgments on where these extraordinary bright and visible colors can be put to work to reduce, and in some instances eliminate, accidents.

Daylight fluorescent colors are brighter than ordinary colors because they act as converters or transformers of light energy. To prove this we are going to return to the high school physics class for a moment and review a couple of terms.

Let's begin with the question, what is daylight?

Daylight can be defined as the energy that is emitted by the sun, travels through space, and strikes the earth's surface. The greatest share of this energy lies within the visible portion of the spectrum--violet, blue, green, yellow, orange and red. On one side of this visible spectrum is invisible ultra-violet and the other side invisible infra-red. But today we are concerned with only the visible portion of the spectrum, which, as you will see, is responsible for color as we know it.

Our next question is, what is color? Color may be defined as the optical effect produced by any portion or portions of the visible spectrum striking the human eye. A series of three filters can demonstrate the effect. For example, a blue-violet filter passes violet and blue light and blocks all the yellow, green, orange and red. A yellow-green filter passes all the yellow-green light in our daylight source and blocks the violet-blue, the orange, and red. An orange-red filter passes orange-red light and blocks all the rest. Thus, a color effect is achieved when portions of our visible spectrum come into contact with the human eye.

What is fluorescence? Fluorescence is defined as the phenomenon in which light energy of a relatively short wavelength is converted into visible light energy of a longer wavelength. In comparing fluorescent and conventional red-orange color examples side by side under simulated daylight, the two surfaces appear quite similar. Both are obviously reflecting red-orange light to our eyes and the primary difference is that the fluorescent example is brighter.

However, when the samples are illuminated with yellow-green light, something very unusual occurs.

The conventional color appears to darken, while the fluorescent surface continues to emit a distinctive red-orange effect. This is due to its ability to convert yellow-green to red-orange, rather than absorbing the transmitted light as does the regular red-orange.

The effect is even more dramatic with short wavelength blue-violet light. Conventional red-orange goes almost completely black, while the fluorescent again continues to emit bright red-orange color. Thus, fluorescent colors are brighter than ordinary colors because they are capable of converting light energy that is normally absorbed and wasted to visible light, which in turn reinforces the color in intensity. Hence, there is greater visibility in daylight conditions.

In fact, certain fluorescent colors are four times brighter than their conventional color counterparts.

It would be appropriate to mention the exceptional visibility fluorescent color exhibits at dawn and dusk and in conditions of limited visibility such as fog and haze. The reason is that the longer wavelengths of light are unable to penetrate haze, so regular colors undergo a general darkening or graying effect. However, fluorescent surfaces convert the short wavelengths into longer wavelengths, reinforcing the fluorescent color. This not only makes it appear more brilliant but also more visible, especially on hazy days.

There is a common misconception among non-technical people that, because these materials are described as having a fluorescent quality, they glow in the dark. Daylight fluorescent colors do not -- repeat do not -- glow in the dark. Only phosphorescent materials are capable of storing light energy and then re-emitting this energy in darkness.

Today, fluorescent colors are used in substantial quantities by a number of industries outside the field of safety, but it is interesting to note that the first major use for this bright color was for a safety application for the military during the early days of World War II. There were periods during the North Africa campaign when our aircraft were dive bombing and strafing our own ground forces. In fact, mistaken identity was occurring nearly 50 percent of the time. The standard colors on ground to air signal devices were just not visible at high altitudes against a desert background. Fluorescent color corrected this situation. The same message panels, this time in fluorescent colors, were visible at altitudes of up to 20,000 feet. Since World War II all three services, Army, Navy and Air Force, have used fluorescent color for air-ground recognition panels, beach markers and landing panels and on aircraft carriers for signaling systems, rescue clothing and many other uses.

Under the impetus of the military, the extraordinary brilliance of fluorescent color has carried over into a vast number of safety situations. The Air Training Command, and subsequently other branches of the military, used literally thousands of gallons of fluorescent paint for markings on aircraft. In the early 1960's the ATC flight training base at Hondo, Texas experienced 9 mid-air collisions under Visual Flight Rules conditions in one year. After the fluorescent marking

program was fully implemented, which involved over 1600, aircraft the number of mid collisions dropped to zero. In fact, there never has been a mid-air collision, during daylight hours, between aircraft with fluorescent markings.

In other aircraft-related applications, there are scores of factual accounts about disaster having been averted because the pilot was able to see either the fluorescent markings of another aircraft or a ground obstacle under conditions of limited visibility.

During the Navy's "Operation Deep Freeze" in the Arctic, a cargo transport crash-landed on an ice floe and the crew survived. They were observed because they propped a broken wing with a fluorescent painted tip against the side of the downed craft at about a 45 degree angle. It was this small patch of bright orange color that caught the eye of an observer in one of the search and rescue aircraft, and as a result they were sighted and their lives were spared.

A familiar picture these days is the major high speed highway undergoing repair, complete with barricades, flags and traffic cones.

This scene is commonplace, it occurs in almost any major U. S. city on any given day. Fluorescent traffic cones are hard at work alerting motorists and pedestrians of a hazardous construction site. Fluorescent color has become the standard color for traffic ones and delineators because of its proven capability to visually communicate the presence of dangerous conditions faster and at much greater distances than can regular color.

Another widely used warning device is the triangle used to alert approaching motorists of slow moving vehicles that travel on public roads and streets. This particular device combines the advantages of fluorescence for daytime in the center, and retroflective tape on the outer edge for nighttime visibility which is highly visible to an overtaking vehicle. The red border of reflective sheeting glows brilliantly when illuminated by automobile headlights. Baggage carts at jet age airports also sport this emblem.

The same principle applies to the Department of Transportation safety triangle, which is mandatory equipment on all interstate truck traffic in the U.S.A. and which has just been adopted by the Japanese Diet for all motorized traffic. Placed behind disabled vehicles, over-taking traffic has sufficient notice to move over or slow down.

On water, the use of fluorescent color with water sports has prevented many accidents and saved many lives. According to Mr. Paul Cerosi, Chief, Division of Watercraft for Ohio's Department of Natural Resources and President of the National Association of Boating Law Administrators, "When life-boats and vests are fluorescent colored, skiers and surfers can be spotted immediately, thus showing they would be recognized and picked up faster in the event of a mishap." The State of Ohio has a law requiring pleasure boaters to carry a fluorescent orange colored distress flag.

In the sports world, fluorescent color plays a role in the reduction of mistaken-for-game accidents. In the early 1960's, Jack Woolner, head of Information and Education section of the Massachusetts Division of Fisheries and Game, became highly concerned about the recurrence of mistaken-for-game deaths in his state, especially among deer hunters. As a result, he spearheaded the search for a solution that involved the cooperative effort of the Massachusetts Division of Fisheries and Game, United States Strategic Army Command and the American Optical Company. The conclusion they reached after extensive evaluation was that fluorescent-colored

safety garments proved to be the most effective answer to this problem.

Let me quote Mr. Woolner's remarks about the importance of fluorescent color in hunter safety.

"Research and tests at the Harvard University Center for Cogitative Studies indicate that any man or woman, expert or novice, with a desire to see a deer and aided by sound or color or movement may be able to see a deer when none exist. Given clues in the form of shape, color or movement, the memory bank in the human mind can supply the missing facts and complete the image of a deer that just does not exist. Extensive tests with conventional and daylight fluorescent colors proved that fluorescent orange is the easiest color to see and recognize in the outdoors. Because this color is unlike anything in nature, according to vision and human behavior authorities, the sight of this man-made color would cause immediate mental rejection of any deer association with the object under observation. It follows that a hunter wearing fluorescent Blaze Orange could not be mistaken for a deer. It's a brilliant color to both people with normal vision and almost all of those who have color deficient vision."

In 1962 the Massachusetts legislature passed a law requiring deer hunters to wear two hundred square inches of daylight fluorescent color. Since that date there is no record of any hunter being shot for game in the state while wearing the correct Blaze Orange garments. The use of Blaze Orange in Massachusetts and Maine has proven that it will reduce deer hunting accidents more than 50%. Since 1962, 39 other states have passed similar legislation. Safety applications of fluorescence abound everywhere. We haven't even touched on existing uses at sea, underwater and even in space. What we have attempted to accomplish today is to first demonstrate why fluorescent color excels over regular colors in brightness and visibility, and secondly, to provide a broad overview of just some of the areas where this unusual brilliance has and is being successfully used. It works so well that some safety experts refer to it as the "Safety Color That Shouts."

I would like to conclude my presentation on this note. The fluorescent color industry is just as eager to find effective solutions to pressing safety needs as you are. One of our primary aims is to identify those areas where the functionality of fluorescent color can be put to work to prevent accidents and save lives.

In this connection, we have had a tremendous amount of experience in working closely with technical people at all levels of government, as well as industrial designers, safety engineers and producers of safety equipment and products. If you have any ideas or projects that you believe fluorescent color should be considered for, and if you have questions about economic or technical feasibility, please feel free to contact us. We will readily put you in direct contact with technical people who are qualified to offer assistance.