https://doi.org/10.2352/ISSN.2470-1173.2018.16.COLOR-225

Can Pop-Tart® Wrappers Be Used to Make Safe Eclipse Glasses?

Katherine Carpenter; Munsell Color Science Laboratory, Rochester Institute of Technology, Rochester, NY, USA
Susan Farnand; Munsell Color Science Laboratory, Rochester Institute of Technology; Rochester, NY, USA

Abstract

Preparations for the "Great American Eclipse" captivated astronomers and the general public alike. With the preparations came numerous warnings about how the eclipse could be viewed safely. There was a suggestion online that Pop-Tart® wrappers, which are made of Mylar®, can be used to create homemade eclipse glasses. Mylar® is a brand name for biaxially-oriented polyethylene terephthalate; it is a metallized plastic sheeting that reflects almost all light and also functions as an insulating material. This could be appealing to novices who don't know any better and who want to be able to look at the sun without having to buy ISO and CE certified eclipse glasses. This could potentially be dangerous if the Pop-Tart® wrappers don't filter out enough of the sun's rays to fully protect the viewer's eyes. This project ascertained the safety of Pop-Tart® wrapper eclipse glasses by comparing their transmission to the transmission of verified glasses from reputable dealers. Transmission measurements were performed with a monochromator and were plotted to compare the data. Measurement results indicate that a double-layered Pop-Tart® wrapper performs comparably with eclipse glasses in the visible range and filters more radiation in the near UV and near IR regions.

Introduction

The Great American Eclipse was both an astronomical and cultural phenomenon the likes of which had not been seen across the United States in nearly 100 years. It seemed that everyone wanted to be a part of the happenings. As such, many vendors of certified eclipse glasses sold out well prior to the eclipse. People who had lagged behind in securing the proper equipment resorted to seeking out alternative methods for viewing the eclipse. Eclipse glasses made in compliance with current ISO standards [1], the standard for products certified as safe to use to directly view the sun, are typically made with black polymer. However, old eclipse glasses used to be made from an aluminized polyester, biaxially-oriented polyethylene terephthalate (boPET), generally known by the brand name Mylar®. As it happens, Pop-Tart® wrappers are also made from Mylar®. Therefore, laypeople theorize, Pop-Tart wrappers can be used as eclipse glasses. Aluminized polyester itself is recognized as a safe filter for viewing the Sun, though warnings specify that, in general, Mylar® wrappers should not be used [2, 3]. No data or measurements supporting the idea that food wrappers cannot be safely used ever appear with these warnings, though. This project attempted to change that by determining how the transmission of Pop-Tart® wrappers compares to the transmission of real, verified eclipse glasses. The transmissions of four types of eclipse glasses from the American Astronomical Society's list of "Reputable Vendors of Solar Filters & Viewers" were measured and compared to the transmission of four different Pop-Tart® wrappers. These results were then compared to determine if Pop-Tart® wrappers can be used to make homemade eclipse glasses or if they really are as dangerous as they are made out to be.

Background

For the first time in 99 years, a total solar eclipse passed over the continental United States on August 21, 2017. Its path from coast to coast earned it the name "The Great American Eclipse." A map of the path of totality is displayed in Figure 1 [4]. Even if one was not within the path of totality, viewers could still experience 60% or more of the Sun's obscuration. Up to 300 million people viewed the eclipse in some form [5]. This put a very obvious strain on the supply of eclipse glasses. Without safe eclipse glasses, people across the United States were looking for a way to view the eclipse without damaging their vision.

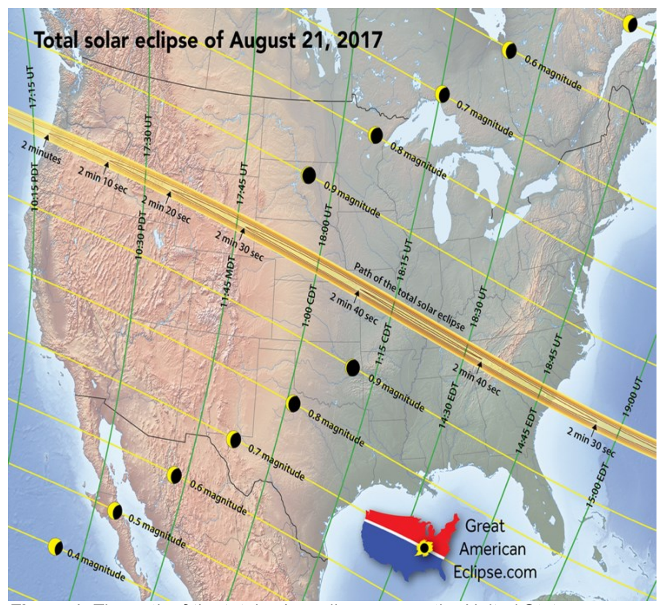

Figure 1. *The path of the total solar eclipse across the United States.*

BoPET, or Mylar®, is a film that can be made to have high tensile strength, high reflectivity, chemical and dimensional stability, as well as additional properties [6]. The surface is highly reflective, and it is thin and flexible, yet still strong and durable. It is used in high atmosphere helium balloons, space blankets, and electronics. It is used in food packaging because it reflects visible and ultraviolet light that would accelerating staling and thus extends the shelf life of the products it contains [7].

Because the boPET wrappers are so highly reflective, it stands to reason that they would transmit very little light. If they block enough of the light that is damaging to human eyes then they could be used as a cheap alternative to eclipse glasses. The fact that eclipse glasses were made from aluminized polyester in the past reinforces this idea. Manufacturers transitioned to use of black polymer over aluminized polyester because it can be somewhat easy to scratch the aluminum coating off the polyester, leaving it transparent and not sufficient as protection against the Sun's harmful radiation. Additionally, black polymer glasses allow the light to retain the yellow color of the Sun; aluminized polyester blocks the harmful radiation but it makes the transmitted light more whitish.

Methods

An Optronic Laboratories 740A-D monochromator was used to measure the transmittance of the eclipse glasses and the Pop-Tart® wrappers. The four sets of glasses came from Rainbow Symphony, LUNT Solar Systems, American Paper Optics, and Seymour Solar; the sources were all known to be reputable dealers of ISO certified eclipse glasses. The four Pop-Tart® wrappers used were taken from four different boxes in order to cover a range of products. The glasses used in the experiment are pictured in Figure 2a-b. An example Pop-Tart® wrapper is pictured in Figure 3.

Figure 2a. *Three pairs of eclipse glasses used in the experiment, the Seymour Solar, LUNT Solar Systems, and American Paper Optics glasses. The American Paper Optics glasses are the pair at the bottom from the Adventure Science Center in Nashville, TN.*

Figure 2b. *The fourth pair of eclipse glasses used in the experiment, the Rainbow Symphony glasses. This pair was the most substantial of the eclipse glasses.*

It was immediately obvious that one layer of the wrappers would not be sufficient to block out an amount of light comparable to the eclipse glasses; therefore, the wrappers were folded over once so the light was passing through two layers of the wrapping. The wrappers were folded such that the writing on what would be the outside of the package faced inwards. The output of light when no filters were in place was measured first. The filters were then measured individually, with the glasses or the wrappers secured in place over the port of the monochromator. The output of the light was measured again and compared to the output without the filter to find the transmittance of that filter. Measurements were taken from every 10 nm in a range of 300-900 nm. 300 nm was chosen as the cutoff point because Earth's atmosphere filters out almost all UV light at wavelengths shorter than UVA; 95% of UV radiation that reaches Earth's surface is UVA (315-400 nm) [8]. The transmittance curves of the eclipse glasses and wrappers were then plotted and compared. Solar irradiance data measured during the eclipse depict the amount of radiation reaching Earth from the Sun between 300 nm and 700 nm [4]. The plot is shown in Figure 4. It can be seen that the irradiance of the radiation decreases is relatively low in the ultraviolet region.

Figure 3. *An example of the Pop-Tart® wrappers measured.*

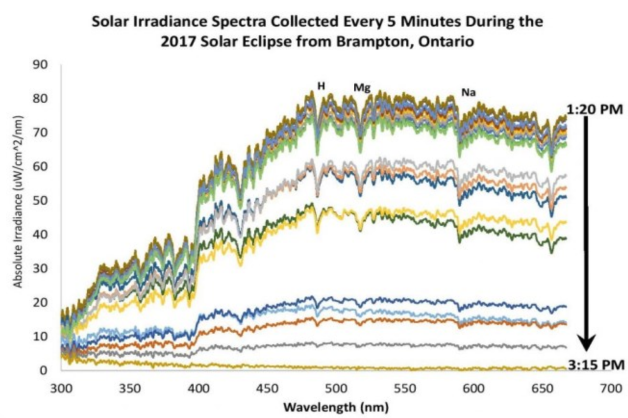

Figure 4. *The irradiance data for the energy from the Sun reaching Earth during the eclipse, as measured and reported by Ocean Optics [5]. The measurements were taken in the range of 70-80% of eclipse, not in the path of totality.*

Results

The transmittance data of the eclipse glasses and Pop-Tart® wrappers are displayed in Figure 5. The four eclipse glasses and the four wrappers can all be seen to have similarly shaped spectra to one another. Apart from one set of glasses, labelled Glasses 3, the eclipse glasses and Pop-Tart® wrappers performed similarly in the visible range, transmitting about 0.01% of light. However, it can be seen that, in both the infrared and ultraviolet ends of the spectra, the transmission of Glasses 2-4 increases exponentially. The wrappers, on the other hand, exhibited a much lower, linear increase in transmission. While Glasses 1, the most heavy-duty of the eclipse glasses, still had the lowest transmission in the infrared at around 0.01%, the wrappers all transmitted between 0.02% and 0.04% at 900 nm. This is significantly lower than the other three pairs of glasses, which transmitted between 0.23% and 0.32% of radiation at 900 nm. The spectra of the Pop-Tart wrappers can be seen more clearly in Figure 5.

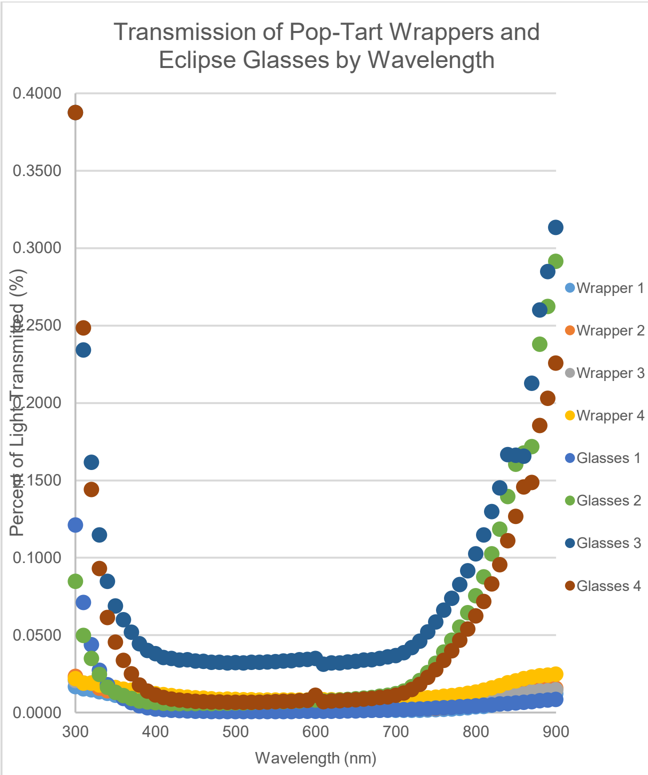

Figure 5. *The transmittance spectra measured of the eclipse glasses and the Pop-Tart® wrappers.*

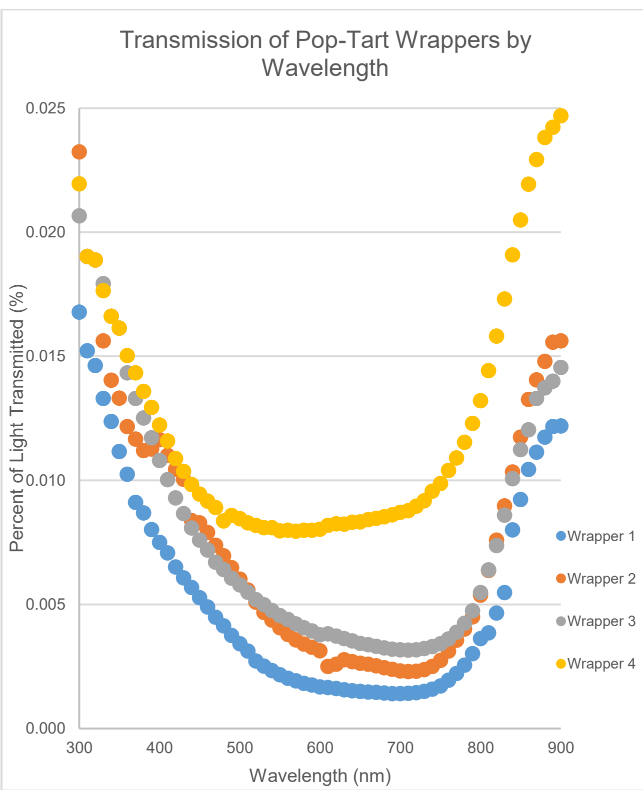

Figure 6*. The transmittance spectra of the four Pop-Tart® wrappers.*

It is apparent in looking at Figure 6 that the transmission of the four Pop-Tart wrappers also exponentially increases in the ultraviolet and infrared regions of the spectrum, just on a smaller scale than those of the eclipse glasses by a power of more than 10. All four spectra follow the same U-shape as exhibited by the eclipse glasses, though one wrapper, Wrapper 4, transmitted around 0.005-0.008% more radiation than the other three wrappers in the visible and infrared range. The transmission of all four wrappers was comparable in the ultraviolet. Since the scale on which the light is transmitted is so small, it is possible that these differences could stem from slight inconsistencies in the thickness of aluminum coating on the polyester. Since this Mylar® isn't specifically for viewing the Sun, it is likely that the manufacturing does not have to be entirely consistent, just consistent enough to keep the Pop-Tarts® fresh. Because of these inconsistencies, the variations in manufacturing could theoretically lead to different thicknesses of the aluminum coating on individual wrappers. Taken to its logical extreme, this could also include unsafe viewing conditions if the aluminized coating is too thin. None of the wrappers measured in this project were in any danger of this, though. Even though the product isn't specially designed for viewing the Sun, the evidence indicates that is still feasible to use the product to do so.

Conclusion

The results indicate that it is indeed feasible to make homemade eclipse glasses using Pop-Tart® wrappers in the event of a shortage of ISO certified glasses. In fact, the Pop-Tart® wrappers were measured to perform better than the eclipse glasses in filtering IR and UV radiation. The aluminized polyester, formerly used in eclipse glasses, performs well in filtering out the harmful amounts of light, though it does give the light a whitish-blue color, whereas the black polymer of current eclipse glasses preserves the yellow color of the Sun. The slight cosmetic difference to the light may still drive consumers to purchase special eclipse glasses, if possible. However, if reputable manufactures have sold out around the time of the next total solar eclipse across the United States in 2024 or the consumers already have Pop-Tarts® on hand, this appears to be another option for safe solar viewing.

References

[1] Eye and face protection -- Sunglasses and related eyewear -- Part 2: Filters for direct observation of the sun, ISO Standard 12312-2:2015, https://www.iso.org/standard/59289.html, 2015.

[2] "SOLAR VIEWING SAFETY," Perkins Observatory, http://perkins.owu.edu/solar_viewing_safety.htm, 2017.

[3] B.R. Chou, "Solar Eclipse Eye Safety," American Astronomical Society, pp. 1-9, 2016.

[4] M. Zeiler, "Overview maps of the 2017 eclipse," Great American Eclipse LLC., https://www.greatamericaneclipse.com/nation/, 2017.

[5] "Spectral Analysis of the Total Solar Eclipse," Ocean Optics, https://oceanoptics.com/spectral-analysis-total-solar-eclipse/, 2017.

[6] M.T. DeMeuse, Biaxial Stretching of Film, 1st ed. Woodhead Publishing, pp. 47-48, 2011.

[7] E.M. Mount III, "Technology of Vacuum Metallized Plastics Packaging," PlasticsTrends, http://www.plasticstrends.net/index.php/last-

months-mainmenu-28/21-technology-of-vacuum-metallized-plastics-packaging, 2006.

[8] National Toxicology Program, "Ultraviolet-Radiation Related Exposures," Department of Health and Human Services, Report on Carcinogens, 14th ed., 2016.

Acknowledgements

The authors would like to thank Dr. Michael Richmond of RIT for bringing the idea of Pop-Tart® wrapper eclipse glasses to their attention.

Author Biography

Katherine Carpenter received her BS in physics from SUNY Oneonta (2011) and her PhD in color science from Rochester Institute of Technology is in progress. Her latest work has been on the color calibration of drone cameras.
Susan Farnand received her BS in engineering from Cornell University and her MS in imaging science PhD in color science from the Rochester Institute of Technology. She is currently an Assistant Professor in the Program of Color Science at the Rochester Institute of Technology. Her research interests include human vision and perception, color science, cultural heritage imaging, and 3D printing.