

Flammability

Due to their chemical nature most untreated plastics will burn. Yet, there are many applications where flame retardancy is a necessary requirement for a plastic part. Let's explore why plastics are flammable/non-flammable and how flammability is characterized by the UL (Underwriters Laboratories) standard.

Why plastics burn:

When plastic is exposed to a flame, the combustion produces volatile polymer fragments. These fragments are oxidized, thus producing more heat. This forms a cyclical combustion that continues to burn until the polymer decomposes.

Flammability resistance occurs if the combustion cycle is interrupted. Flame retardancy happens when the material creates a volatile that smothers the flame, the material chars to prevent further burn, or the material has an additive that acts as a heat sink to absorb the heat energy and extinguish the fire.

Some plastics are inherently flame retardant. These include fluorinated (PTFE) and aromatic polymers. Silicone, polysulfone, and LCP (liquid crystal polymers) have some flame retardant properties and can see high flame retardancy with the addition of additives. All other polymers are more difficult to obtain flame retardancy due to their rapid decomposition.

The Underwriters Laboratories (UL) developed a standardized burn test to classify the level of flame retardancy. The test, UL 94, quantifies the burning characteristics of a material in the horizontal and vertical positions. Several ratings can be applied based on the rate of burning, time to extinguish, ability to resist dripping, and whether or not the drips are burning. It's possible a material receives different ratings based on color or sample thickness.

Summary of the UL 94 rating categories¹:

- HB Slow burning on a horizontal specimen burning rate <76 mm/min for thickness <3mm. Drips of flaming particles are allowed.
- V-2 Burning stops within 30 seconds on a vertical specimen; drips of flaming particles are allowed.
- V-1 Burning stops within 30 seconds on a vertical specimen; no drips allowed.
- V-0 Burning stops within 10 seconds on a vertical specimen; no drips allowed.
- 5V Burning stops within 60 seconds after five applications of a flame – larger than used in V testings – each of five seconds, to a test bar. No drips allowed.
- 5VB Plaque specimens may have a burn-through hole.
- 5VA Plaque specimens may not have a burn-through hole. (highest UL rating)

An understanding of flammability and its characteristics is critical for plastic part design since plastic parts are continually being utilized in applications where flame retardancy is necessary. This article introduces the concepts of flammability and discusses the UL criterion for flammability resistance. We hope this article helps in your understanding of flammability of plastics.

¹ Campo, E. Alfredo, *The Complete Part Design Handbook*, Hanser, 2006.

² Strong, A. Brent, *Plastics: Materials and Processing*, Prentice Hall, 2000.