

# A Strategic Research Initiative for the Optimization of a Textile Fire Barrier Without Flame Retardants for Upholstered Furniture

## Introduction

According to the National Fire Protection Association (NFPA), ignition of upholstered furniture is a significant contributor to deaths (22%) in reported home fires.<sup>1,2</sup>

Most of these deaths occur when open flames are present and the fire spreads beyond the initial source.<sup>3</sup> Upholstered furniture is one of the largest fuel loads in a typical home, causing full room involvement with low oxygen levels and extremely high temperatures.<sup>4</sup> The use of a barrier material has been found effective in delaying the involvement of upholstered furniture filling materials in a fire incident.<sup>4-6</sup> Fire suppression strategies specifically aimed at reducing open flame involvement of upholstered furniture may reduce the number of deaths attributed to home fires.

Previous studies on the availability and effectiveness of fire barriers used in upholstered furniture have been conducted by the National Institute of Standards and Technology (NIST),<sup>5,7-9</sup> The State of California Department of Consumer Affairs Bureau of Household Goods and Services (BHGS),<sup>4</sup> and Chemical Insights Research Institute (CIRI).<sup>6,10,11</sup> These studies found that barriers extended flashover from six to seven minutes to 21 minutes or more. Multiple barriers currently on the market met the criteria for smolder and open flame testing. Interestingly, those barriers outperformed other flame suppression technologies as well as upholstered furniture with no flame suppression technologies. However, these studies did not fully account for barrier chemical compositions.

Chemical exposure risks can occur both during normal use of the upholstered furniture product and during a structure fire. CIRI's prior research<sup>12</sup> shows that classes of flame retardants traditionally used in polyurethane foam (PUF), as used in furniture cushioning, are detected in experimental studies during consumer chair use.

The most significant exposure route is dermal transfer, followed by ingestion and inhalation. Data from product burns shows that flame retardants used in upholstered furniture are found in the burning emissions at significantly higher levels than what is found during typical consumer use simulations. This study also found that mechanically aged chairs measured lower levels of flame retardants than new chairs.<sup>12</sup>

The intersection between chemical safety and fire suppression for upholstered furniture is the focus of this study. The challenge is to identify chemical or technical solutions that do not compromise health while providing a solution that will deliver flammability suppression to minimize the fuel load in a structure fire. Our findings will contribute to the existing knowledge on fire suppression strategies for home fires.



## Study Objective

The objective of this study is to determine a barrier solution for upholstered furniture that maximizes fire suppression while minimizing chemical exposure risks for occupants during normal use.

---

## Study Plan Overview

The study objective will be achieved using the following sampling and assessment plan.

1. Existing barrier textiles that meet the initial assessment criteria, including material specification and no documented use of chemicals linked to health risks will be identified.
2. Barrier textiles will be tested to determine which materials meet the U.S. Consumer Safety Commission (CPSC) Federal Flammability Standard for Upholstered Furniture Fires using the State of California Technical Bulletin 117-201313 (TB 117-2013) smolder resistance test.
3. Barrier textiles will be tested to determine their fire suppression capabilities by utilizing a small-scale open flame test.<sup>4</sup>
4. Material chemical composition of the barrier textiles will be analyzed for substances that may be contrary to the objective of chemical safety during normal use.
5. Barrier textiles that meet the performance criteria of the smolder test, open flame test, and material composition analysis will be modified to enhance material design and meet flexibility requirements for layering under the cover fabric of a seat cushion.
6. Modified textile barriers will be evaluated by smolder and open flame testing, and material chemical composition analysis.
7. Seat cushions utilizing all barrier textiles that have met the above conditions will be evaluated using an open flame test that will collect data on burn characteristics, heat and smoke release rates, total weight loss rate, gas emissions, smoke yield, and chemical and dust emissions.
8. Chairs made using the optimized barrier textiles will be tested using a full-scale open flame test to determine fire suppression performance in the residential environment.<sup>12</sup> This full scale burn test using upholstered furniture will evaluate burn characteristics, heat and smoke release rates, total weight loss rate, gas emissions, smoke yield, and chemical and dust emissions.

## Scientific Outcomes

01

Characterization of chemical composition for selected available barriers.

02

Evaluation of TB 117-2013 smolder and open flame suppression for selected available barriers.

03

Development of an optimized barrier for protection and without flame retardants for upholstered furniture for consumer use.

---

## Research Partners

Debra Harris, Ph.D., RAD Consultants, Baylor University

Fire Safety Research Institute of UL Research Institutes

Various commercial fabricators

## REFERENCES:

1. Ahrens, M. & Maheshwari, R. Home Structure Fires. (National Fire Protection Association, Quincy, MA, 2021).
2. Ahrens, M. Soft furnishing fires: they're still a problem. *Fire and Materials* (2020). <https://onlinelibrary.wiley.com/doi/10.1002/fam.2874>
3. Hall, J. R. Estimating Fires When a Product is the Primary Fuel But Not the First Fuel, With an Application to Upholstered Furniture. *Fire Technol* **51**, 381-391 (2015). <https://link.springer.com/article/10.1007/s10694-014-0391-8>
4. BHGS. Summary Report of Barrier Research. (Bureau of Household Goods and Services, Sacramento, CA, 2018).
5. Zammarano, M. *et al.* Reduced-scale test to assess the effect of fire barriers on the flaming combustion of cored composites: An upholstery-material case study. *Fire and Materials* (2020). <https://doi.org/10.1002/fam.2910>
6. Harris, D. *et al.* Chemical exposure and flammability risks of upholstered furniture. *Fire and Materials* (2020). <https://doi.org/10.1002/fam.2907>
7. Zammarano, M. *et al.* Smoldering and Flame Resistant Textiles via Conformal Barrier Formation. *Adv. Mater. Interfaces* **3** (2016). <https://doi.org/10.1002/admi.201600617>
8. Zammarano, M. *et al.* *NIST Technical Note 2129* (ed NIST) (U. S. Department of Commerce, Gaithersburg, MD, 2020).
9. Zammarano, M. *et al.* Flammability reduction of flexible polyurethane foams via carbon nanofiber network formation. *Polym Adv Technol.* **19**, 588-595 (2008). <https://doi.org/10.1002/pat.1111>
10. Black, M., Davis, A., Harris, D., Ryan, P. B. & Cohen, J. R. A Study of Chemical Exposure Risk and Flammability of Upholstered Furniture and Consumer Electronics. 57 (Chemical Insights, Underwriters Laboratories Inc., Atlanta, GA, 2019).
11. Davis, A., Ryan, P. B., Cohen, J. A., Harris, D. & Black, M. Chemical exposures from upholstered furniture with various flame retardant technologies. *Indoor Air* (2021). <https://onlinelibrary.wiley.com/doi/10.1111/ina.12805>
12. UL. A Study of Chemical Exposure Risk and Flammability of Upholstered Furniture and Consumer Electronics. (Underwriter Laboratories, Marietta, GA, 2019).
13. BHGS. *Technical Bulletin 117-2013* (ed Bureau of Household Goods and Services) (State of California Department of Consumer Affairs, Sacramento, CA, 2013).

