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Original
How to reduce the flammability of plastics and textiles through surface treatments: recent advances / Malucelli, Giulio. - In: COATINGS. - ISSN 2079-6412. - ELETTRONICO. - 12:1563(2022). [10.3390/coatings12101563]

Publisher:
MDPI

Published
DOI:10.3390/coatings12101563

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Editorial

How to Reduce the Flammability of Plastics and Textiles through Surface Treatments: Recent Advances

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The high flammability of plastics, polymer composites, textiles, and foams represents a severe and stringent issue that significantly limits their use in all those sectors, where resistance to a flame or an irradiative heat flux is mandatory. To face and solve this problem, several types of effective flame-retardant systems have been designed, synthesized, and successfully applied to flammable materials [1].

These flame-retardant additives can be either incorporated into the polymer [2–4] or can be surface-engineered [5]. In this latter case, it is possible to design suitable coatings that are able to protect the underlying substrate without altering its overall bulk behavior. Undoubtedly, the surface of flammable materials acts as the interface between the condensed and the gas phase during combustion events; therefore, any chemical or physical modification of this interface can be remarkably important for the control of the occurring heat and mass transfer phenomena. In this context, the use of suitable flame-retardant coatings can limit the heat transfer to the bulk, hence slowing down the diffusion of the volatile flammable species, originating from the thermal degradation of the material, toward the surface and then to the gas phase, where the flame is fed.

The scientific literature reports several examples concerning the use of flame-retardant coatings for different plastic substrates. Up to now, a Special Issue of the *Coatings* journal (*Flame-Retardant Coatings for Plastics and Textiles*) collected six papers (including two reviews) which focus on the design, preparation, and application of flame-retarded coatings for polymer systems.

In particular, Pomázi and Toldy [6] reviewed the potentialities of gelcoats for composite materials, as they exhibit good water resistance, electric conductivity, and flame retardance. Moreover, they discussed the standard and novel methods used for preparing these gelcoats, particularly in reference to in-mold gel coating, UV curing, spraying, and brush/roller application, finally elucidating the common defects that may originate during the gel-coating processes.

Another review paper [7] thoroughly investigated the suitability of two main surface-engineered systems, namely sol–gel-derived coatings and layer-by-layer (LbL) architectures for conferring flame-retardant features to cotton fabrics. Again, the multifunctional potential of these surface treatments (i.e., flame retardance, hydrophobicity, electrical conductivity) was clearly highlighted and strictly correlated with the composition of the sol–gel recipes, as well as with the type of layer constituents in the LbL assemblies.

Koštial and co-workers [8] investigated the fire characteristics of sandwich structures that are employed to construct external or internal parts of vehicles. In this study, different parameters were taken into account, namely the sandwich thickness (i.e., the number of laminating layered prepregs), the type of core material (PET foam, honeycomb made of Nomex paper type T722 of different densities, and aluminum honeycomb), and the possible application of a composite coating based on a glass-reinforced phenolic matrix. The time to ignition of the sandwich structures as well as the maximum average heat release rate were found to increase with an increasing the number of lamination layers. Furthermore, the fire behavior was negatively affected by the presence of the composite coating.

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Citation: Malucelli, G. How to Reduce the Flammability of Plastics and Textiles through Surface Treatments: Recent Advances. *Coatings* **2022**, *12*, 1563. https://doi.org/10.3390/coatings12101563

Received: 29 September 2022
Accepted: 14 October 2022
Published: 17 October 2022

Abuhimd and co-workers [9] investigated the effect of incorporating magnesium aluminate nanoparticles at different loadings into a flame-retarded intumescent epoxy coating, containing ethylenediamine-modified ammonium polyphosphate and charring-foaming agents. As assessed by vertical flame spread tests, the addition of magnesium aluminate nanoparticles accounted for V-0 rating for all the filled coating formulations, irrespective of the nanofiller loading. Moreover, cone calorimetry tests revealed that the presence of the nanoparticles was responsible for an important decrease in both the heat release rate peak and the total heat release.

All the aforementioned examples clearly indicate that the formulation of various types of coatings can be a winning solution for conferring effective flame-retardant features to different plastic substrates, without altering the bulk properties of these latter. Though a lot of work has already been carried out, it is likely to foresee further advances, in the near future, to more effectively exploit these surface-engineered approaches, increase their flame-retardant effectiveness, and widen their potential application fields.

Funding: This research received no external funding.

Conflicts of Interest: The author declares no conflict of interest.

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