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Flame-Retardant Self-Healing Polymers: A Review

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Abstract: *Flame retardant self-healing polymers are materials that can withstand fire and repair themselves. They can be used in a variety of applications, such as fire protection materials, protective creams, and fire extinguishers. Developing multifunctional flame retardants (FRs) has become a strategy to reply on needs for advanced polymers. Self-healing polymers are an emerging class of advanced polymeric materials, which have been upgraded progressively, and recently have taken the advantage of fire safety. Correspondingly, diverse industries like aerospace, automotive, construction and consumer electronics are benefited from flame-retardant self-healing polymeric materials, which underlines their increasing contribution to modern technologies. The self-healing characteristics stem from intricate chemical and physical interactions, adopting self-directed repair mechanisms leading to eliminating the need for frequent replacements, subsequently lowering maintenance costs and environmental impact. This review summarizes advantages of self-healing polymers with emphasis on exploring highly innovative advancements among bio-based hydrogels, aerogels, coatings, thin films, lithium-ion batteries and advanced ionotronic skin (-i-skin) structures embedding sensing features for smoke detection and flame exposure warnings, further broadening their application in smart technologies and safety-critical infrastructure. The outcomes of reports outline challenges remaining in developing such multifaceted materials in view of lack of information due to limited or exclusive investigations. However, further research may facilitate exploring dehydration, thermal shielding, and free radical quenching mechanisms contributing to flame retardancy performance of flame-retardant self-healing polymers. Sustainability and circular economy requirements are briefly discussed, in addition to outlining remarks on future developments.*

Keywords: flame retardancy; polymer composites; fillers; magnesium hydroxide; fire; thermal properties; cladding

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