Multilayers of Graphene Oxide to Produce Self-extinguishing, Non-ignitable and Flame Resistant Flexible Polyurethane Foams

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Polymer foams are widely used in many different applications in buildings, furniture and transport. In many of these applications a controlled reaction to a flame exposure and a sufficient resistance to the flame is requested to guarantee safety in event of fire. The traditional way of flame-retarding polymer foams is based on halogenated additives. However, these additives pose severe environmental and health concerns and are being progressively banned. Futhermore, the toxicity and optical density of the smoke produced in the presence halogenated flame retardants are additional drivers for the urgent substituition of the traditional solution with effective and sustainable alternative solution.
The surface deposition of a thin submicrometric layer has recently been demonstrated effective in flame retardancy of foams. [1, 2] Here water-based suspensions of graphene oxide (GO) nanoplatelets have been exploited to conformally coat the surface of flexible foams by employing either a layer by layer or an innovative solvent casting approach.
The treated foams were capable of self-extinguishing the flame and completely suppressing the melt-dripping phenomenon during flammability tests. Furthermore, these GO-based coatings were found able to prevent ignition of the foam when exposed to heat fluxes typical of developing fires (35 kW/m^2). Surprisingly, flame penetration tests demonstrated that GO-treated PU foams are able to withstand an impinging flame and to maintain and excellent thermal insulation, with a gradient of about 700°C/cm, comparable in performance to a commercial silica aerogel within the first 5 minutes of flame applications (Figure 1). A comparison with other nanoparticles (e.g. silica, montmorillonite) demonstrated the superior properties achieved by GO-based coatings.
The easy, sustainable and industrially viable proposed paved the way to the development of a new generation of fire-safe materials based on graphene.

References

[1] G Malucelli, F Carosio, J Alongi, A Fina, A Frache, G Camino Materials Science and Engineering: R: Reports 84 (2014) 1
[2] F Carosio, J Alongi, ACS Applied Materials & Interfaces 8 (2016) 6315

Figures

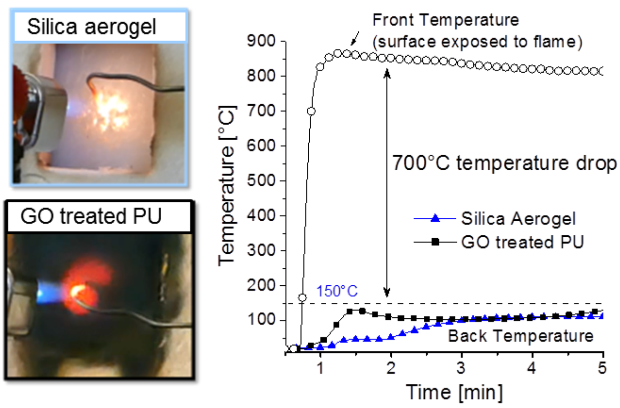

Figure 1: GO treated PU and Silica aerogel snapshots and temperature profiles during flame penetration tests.