Electronic Supplementary Material (ESI) for Journal of Materials Chemistry

Electronic Supplementary Information (ESI†)

State of the art and perspectives on sol-gel derived hybrid architectures for flame retardancy of textiles

Jenny Alongi and Giulio Malucelli*

Dipartimento di Scienza Applicata e Tecnologia, Politecnico di Torino,

Viale Teresa Michel 5, 15121 Alessandria, Italy

Assessment of the the flame retardancy properties

In order to describe a realistic fire scenario, it is important to test both the ignitability of a sample in presence of a flame spread (flammability) and the combustion behaviour of the same sample under an irradiative heat flow, developed as a consequence of the flame exposure. Therefore, the flame retardancy properties of the untreated and sol-gel treated samples were measured through two different tests.

The flammability test in vertical configuration was carried out by applying a methane flame for 5s at the bottom of a fabric specimen (50 x 150mm^2) and repeating the application at least two times. This test aims to mimic the procedure described in ISO15025 standard, commonly employed for the protective garments, although the specimen size used in the present work is smaller (i.e. 50 x 150mm^2 vs. 160 x 200mm^2 in ISO15025).
Alternatively, when the test was performed in horizontal configuration, the flame was applied on the short side of the specimen (50 mm). These tests were repeated 5 times for each formulation. Total burning time and rate after the flame applications and the final residue were evaluated.
A similar test was used by Brancatelli et al. [S3], according to ASTM 1230.

Cone calorimetry (Fire Testing Technology, FTT) was employed to investigate the combustion behaviour of square samples (100 x 100 x 0.5mm^3) under an irradiative heat flow of 35kW/m^2 in horizontal configuration, following the procedure described elsewhere [S1]. Such procedure was designed following ISO5660 standard for plastic substrates.
The fabrics were placed in a sample holder and maintained in the correct configuration by a metallic grid. Time To Ignition (TTI, s), Total Heat Release (THR, kW/m^2), Heat Release Rate (HRR, kW/m^2) and peak (pkHRR, kW/m^2). The higher the TTI, the lower THR and pkHRR, the better is

the flame retardancy performance [S2]. Total Smoke Release (TSR, m^2/m^2), Specific Extinction Area (SEA, directly proportional to the smoke optical density, m^2/kg), CO and CO_2 yield ([CO] and [CO_2], kg/kg or ppm/%) were evaluated, as well. Obviously, the lower the TSR and SEA, the better is the flame retardancy.

For each sample, the experiments were repeated four times in order to ensure reproducible and significant data.

References

[S1] J. Tata, J. Alongi, F. Carosio, A. Frache. Optimization of the procedure to burn textile fabrics by cone calorimeter: part I. Combustion behavior of polyester, Fire and Materials, 2011, 35, 397-409.

[S2] B. Schartel, M. Bartholmai, U. Knoll. Some comments on the main fire retardancy mechanisms in polymer nanocomposites. Polymers for Advanced Technologies, 2006, 17, 772-776.

[S3] G. Brancatelli, C. Colleoni, M.R. Massafra and G. Rosace, Polymer Degradation and Stability, 2011, 96, 483-490