A NEW TYPE OF FLAME RETARDANT FOAM BASED ON A SUSTAINABLE BIOHYBRID MATERIAL OF WHEAT GLUTEN AND SILICA

Qiong Wu,[a] Richard T. Olsson,[a] Richard Andersson,[a] Eva Johansson,[b] Mikael S. Hedenqvist,[a]

[a]KTH Royal Institute of Technology, School of Chemical Science and Engineering, Fibre and Polymer Technology, SE-10044 Stockholm, Sweden.
(qiongwu@kth.se, rols@kth.se, riander@kth.se, mikaelhe@kth.se)
[b]Department of Agrosystems, The Swedish University of Agricultural Sciences, SE-23053, Alnarp, Sweden.
(Eva.Johansson@slu.se)

ABSTRACT

Polymeric foams are commonly used in many applications (e.g. packaging, thermal insulation, and buoyancy) where porous and lightweight structures are useful. However, polymeric foams are almost exclusively petroleum-based and burn with high flammability. In this work, a new type of flame retardant biofoam of wheat gluten and silica is presented as hybrid materials of intermixed phases. Morphology, pore size, thermal insulation property, mechanical property, protein solubility and flammability of the biohybrid foams were characterized as related to freeze drying conditions, i.e. conventional freezing (-25 °C) and rapid freeze (quenching -196 °C). It is demonstrated that an integrated phase of silica dioxide provides excellent flame retardant properties, as determined from the UL94 vertical burning test. It was also found that the best fire retardant properties were obtained from biohybrid foams containing 8.7 wt.% silica or higher. The silica nanoparticles formed in-situ in the wheat gluten matrices provided a protective and stable surface layer of nanoparticles that prohibited flame transformation to the material interiors during burning. The top nanometer surface chemistry of those foams (before and after burning) was characterized by using X-Ray Photoelectron (XPS), Infrared (IR) spectroscopy, Field-Emission Scanning Electron Microscopy (FE-SEM). In addition, wheat gluten-silica biohybrid foams are successfully reinforced by glutaraldehyde (GA), behaving as a cross-linker to reinforce the wheat gluten structure.

Keywords: Foam, wheat gluten, flame resistance, freeze-drying, mechanical properties, cross-linker

Acknowledgement: This work is supported by the Swedish Research Council Formas (NO. 243-2011-1436)