Fire-resistant nanocontainers

August 1 2018

Credit: AI-generated image (disclaimer)

Polymers play an essential role in our daily lives, but they also come with an increased risk of fire. Efficient flame retardants are key to ensuring the safety of humans and safeguarding goods from the dangers of accidental fires.

The polymer industry has turned to flame retardants to reduce the impact of fires caused by highly flammable polymers. However, conventional flame retardants like halogenated compounds have some serious drawbacks like environmental persistence and toxicity. What is more, their use is currently limited by the European Commission's REACH regulation concerning the registration, evaluation, authorisation and restriction of chemicals.

The development of fire-resistant nanomaterials to enhance both mechanical and thermal properties is considered one of the most promising challenges in the flame retardancy domain. The EU-funded NOFLAME project "opened the door to novel approaches in flame retardancy and the understanding of polymer degradation, thus expanding the application of polymers to nanomaterials," says coordinator Dr. Katharina Landfester. "Together with their environmental friendliness – halogen-free flame retardants – and their economic competitiveness, these materials will begin to attract commercial interest."

Nanomaterial dispersion resolution

Project partners synthesised novel nanocontainers to solve the problems of poor dispersion and low interfacial adhesion of inorganic and hybrid nanomaterials. This would make them suitable for flame retardant applications, particularly with the encapsulation of organic and inorganic flame-retardant compounds. "It will lead to new applications, where the application of organic shells is limited by their low thermal stability and high flammability," explains Dr. Landfester.

"The ability to encapsulate a wide range of substances makes the nanocontainers very desirable in developing multifunctional nanomaterials for future applications," Dr. Landfester points out. The encapsulation of paraffin waxes – a thermal energy storage material for buildings – is one such example.

Scientists achieved a high stability of the emulsion over months without the addition of any lipophobe. They observed that the use of a microfluidiser for homogenisation provided more uniform particle size distribution and gave greater stability, repeatability and scalability of the emulsion compared to the ultrasonication method.

The nanocontainers embedded in the polymeric matrices displayed a good dispersion in epoxy resins, a notable rise of the char at 600 ºC and a reduction of the total heat release. This means that the nanocontainers burn more slowly than the reference commercial material.

Paving the way for flame retardant nanocontainers

Findings show that the synthesised nanocontainers improved thermal stability and decreased flammability when embedded in epoxy resins. "NOFLAME will directly result in an improved understanding of flame retardant mechanisms and dispersion of polymeric structures by other researchers in flame retardant nanomaterials and colloid science," Dr. Landfester explains.

Research efforts have also contributed to the knowledge of the scale-up of polymeric mini-emulsion via microfluidiser. The project team is currently performing scaling studies of new materials for bio-applications. "Our research will have an important impact on the polymer industry because companies are actively seeking to change their conventional flame retardants for others less toxic that are in line with REACH," concludes Dr. Landfester.

Provided by CORDIS