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OB.6 Incorporation of iron-based nanochains into poly(vinylidene fluoride-co-hexafluoropropylene) films and their near- and mid-infrared shielding applications

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The infrared (IR) shielding materials become more and more important due to their applications as barriers or filters against IR radiation and resulting heating effects in wearable IR shield, solar filters, solar collectors, optical fibers, stealth technology, and so-called smart windows which aim to limit or increase the indoor temperature during summer or winter season, respectively [1]. However, in order to apply them, they should take a form of thin film coatings deposited on glass/polymer substrates or be used as fillers of glass/polymer. The first strategy usually reveals several technological problems. Hence, the second approach has been recently found to be more convenient.

One of the polymers which is suitable for serving as a matrix for the IR shielding materials, is poly(vinylidene fluoride-co-hexafluoropropylene) (PVDF-HFP). This material is characterized by excellent chemical resistance, non-toxicity, lightweight, high hydrophobicity, thermal and mechanical stability [1]. In turn, among many candidates for IR shielding materials, the tungsten compounds are the most frequently exploited due to their high transparency for visible radiation and strong near-infrared shielding ability. However, they are unstable under a strong ultraviolet radiation and tend to be oxidized by oxygen in the humid or alkaline environment. Therefore, the search of new IR shielding materials is one of hot research topics in the scientific society.

In our previous work [1], we demonstrated a successful incorporation of iron nanoparticles (Fe NPs) into PVDF-HFP films and their application as the IR shielding materials. Based on this report, we decided to investigate whether the iron nanochains (Fe NCs) and iron-cobalt nanochains ($\text{Fe}_x\text{Co}_{1-x}$ NCs; where $x = 0.75$ or 0.25) embedded in the same polymer films would also be suitable as the IR shielding materials. Both Fe and $\text{Fe}_x\text{Co}_{1-x}$ NCs were prepared through a magnetic-field-induced synthesis [2,3]. Then, 5 and 10 mg of each material were introduced into the PVDF-HFP films. The IR shielded tests revealed that the transmittance of films decreased with increasing content of the iron-based nanochains inside them. Moreover, it was found that the PVDF-HFP films filled in the Fe and $\text{Fe}_x\text{Co}_{1-x}$ NCs almost did not reflect the NIR and MIR radiation. These observations indicate that the PVDF-HFP films filled with the iron-based NCs could be considered for IR antireflective and shielding applications.

References

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