EXPLOITATION OF TANNIC ACID AS ADDITIVE FOR THE ADHESION ENHANCEMENT OF UV-CURABLE BIO-BASED COATING

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Nowadays, great attention has been focused on the development of environmentally friendly and sustainable coatings. Within this framework, the exploitation of bio-renewable and natural sources and green polymerization techniques is growing [1]. UV-curable coatings from several vegetable oils, like epoxidized soybean oil (ESO), have been proven potential alternatives to the traditional coating systems [2]. However, the improvement of UV-cured bio-based coatings adhesion has become one of the key issues and natural polyphenols have been revealed to be prominent sustainable adhesion promoters [3].

The current work investigated the natural tannic acid (TA) as an additive to enhance the adhesion performance of the UV-curable ESO-based coating on a low-carbon steel. To homogeneously disperse the tannic additive into the coating formulation, TA solutions with two different concentrations were prepared and added with different weight ratios. The assessment of cationic photopolymerization was performed through real-time FTIR and photo-DSC analyses. The TA addition significantly increased the epoxy group conversion thanks to a chain-transfer process, named activated monomer mechanism [4], which involves the multiple phenols of TA. After 90 s of UV exposure, the conversion of ESO/TA coatings reached around 90%, while the pristine ESO formulation, without the tannic additive, showed a conversion of about 72%. Nevertheless, the DMTA showed that the coating crosslinking density reduced as the TA amount increased due to the activated monomer mechanism. Lastly, the tannic additive remarkably enhanced the UV-cured ESO coating adhesion property on low-carbon steel substrates as the TA polyphenols can coordinate iron. Moreover, the steel surface pretreatments influenced the adhesion performance. Indeed, an outstanding adhesion with the tannic additive was found both for the pickled steel samples and on the steels pretreated with the more safe and eco-friendly plasma technique.

In conclusion, a noteworthy adhesion improvement on low-carbon steel was achieved by the addition of natural TA into a UV-curable bio-based coating. The tannic additive participated in the photocrosslinking reaction with the enhancement effect on the conversion and coordinated iron on the steel surface, acting thus as a “bridge” between the sustainable coating and the metallic substrate.

References

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