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CONTRIBUTIONS

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Enrichment of the surface of an organic coating with silver and copper particles for antimicrobial activity

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The fight against Legionella contamination continues to represent one of the major public-health concerns [1], particularly in hospital water systems and domestic environments, where water stagnation creates favorable conditions for bacterial proliferation. In this context, the development of new strategies for prevention and active control is of fundamental importance. Among the various approaches currently under investigation, particular attention has been devoted to exploiting the well-documented antibacterial properties of silver and copper—used individually or in combination—to inhibit microbial growth in water distribution systems. The presence of silver or copper particles on a surface in an aggressive environment enables the formation of silver or copper ions, which have been shown to exhibit antimicrobial activity [2, 3, 4]. Considering the issue of Legionella, the environment involves the constant presence of water or humidity—often under stagnant conditions. The surface should exhibit antibacterial activity while at the same time providing excellent corrosion protection.

This study aims to design and optimize an epoxy-based coating capable of exposing silver, copper, and silver–copper compound particles on its surface, in order to provide both antimicrobial activity and corrosion protection.

A commercial epoxy paint, Eporex ESN 82, produced by EP Vernici (Solarolo, RA), suitable for contact with food, was used. Table 1 reports the considered samples.

Table 1 analyzed samples.

Samples	% Copper	% Silver
Ref.	----	----
Ag	---	3
Cu	3	---
AgCu	1.5	1.5

Micrometric particles were mixed with the paint prior to deposition. The paint was spray-applied onto a steel substrate to obtain a dry film thickness of approximately 150 µm.

The first antibacterial tests did not reveal any antimicrobial activity against Legionella probably because of the number of particles exposed on the surface was insufficient for an antibacterial effect. Cross-section analysis showed that, due to their high density/weight, the particles tended to sink into the epoxy matrix during the curing process. As a result, the embedded particles were unable to exert any bactericidal effect. In addition salt-spray chamber exposure showed a poor adhesion between coating and the steel substrate compromise the protective performance.

A improved modified deposition procedure, silver, copper, and silver–copper particles were sprayed onto the coating approximately 30 minutes after its application, during the early stages of epoxy crosslinking, allowing the particles to remain on the outermost layer of the coating. The newly developed coatings were thoroughly characterized through a series of physico-chemical analyses, including surface-roughness measurements, contact-angle evaluation, gloss determination, and optical and SEM microscopy. These analyses demonstrated that the modified coatings exhibited improved surface morphology.

The protective properties were evaluated through exposure tests in a salt-spray chamber (ASTM B117 standard). Enhanced corrosion resistance was observed compared with both the standard epoxy coating and the earlier formulations containing incorporated particles. These improvements were attributed to the protruding particles uniformly distributed across the surface. Additionally, the newly introduced pretreatment steps significantly improved the coating's adhesion to the steel substrate, indicating promising applicability in the context of water pipes and storage tanks. Abrasion tests revealed negligible weight loss for the new surfaces, an advantageous characteristic for applications involving contact with food or drinking water. The coatings containing only silver exhibited the most favorable overall properties compared with both the standard sample and those enriched with copper or the silver–copper composite. Preliminary microbiological tests revealed promising activity against Staphylococcus aureus, indicating that the improved coating strategy successfully restored the antibacterial potential of silver and copper. These results suggest that this system could be a promising applications aimed at reducing microbial contamination in water-storage and distribution infrastructures, particularly considering Legionella bacteria.

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[1] B.M.W. Diederen, Journal of Infection 56, 1-12 (2008)
[2] E. Dube, G. E. Okuthe, Microbiol. Res. 16, 110 (2025)
[3] F. Russo, B. Furlan, M. Calovi, O. Massidda, S. Rossi, Surf. & Coat. Technol. 445, 128702 (2022)
[4] P.S. Harikumar, A. Aravind, Int. J. Sci. 83-90, 2 (2016)