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Fabrication Methodologies for Anti-microbial Polypropylene Surfaces with Leachable and Non-leachable Anti-microbial Agents

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Abstract : Aims: Develop a methodology for the fabrication of anti-microbial polypropylene (PP) surfaces with (i) leachable copper (II) chloride dihydrate ($CuCl_2 \cdot 2H_2O$) and (ii) non-leachable magnesium hydroxide ($Mg(OH)_2$) biocides. Methods and Results: Two methodologies are used to develop anti-microbial PP surfaces. One method involves melt-blending and subsequent injection molding, where the biocide additives were compounded with PP and subsequently injection-molded. The other method involves the thermal embossing of anti-microbial agents on the surface of a PP substrate. The obtained biocide-bearing PP surfaces were evaluated against E. coli K-12 MG1655 for 0, 4, and 24 h to evaluate their anti-microbial properties. The injection-molded PP bearing 5% $CuCl_2 \cdot 2H_2O$ showed a 6-log reduction of E. coli K-12 MG1655 after 24 h, while only 1 log reduction was observed for PP bearing 5% $Mg(OH)_2$. The thermally embossed PP surfaces bearing $CuCl_2 \cdot 2H_2O$ and $Mg(OH)_2$ particles (at a concentration of 10 mg/mL) showed 3 log and 4 log reduction, respectively, against E.coli K-12 MG1655 after 24 h. Conclusion: The results clearly demonstrate that $CuCl_2 \cdot 2H_2O$ conferred anti-microbial properties to PP surfaces that were prepared by both injection molding as well as thermal embossing approaches owing to the presence of leachable copper ions. In contrast, the non-leachable $Mg(OH)_2$ imparted anti-microbial properties only to the surface prepared via the thermal embossing technique. Significance and Impact of The Study: Plastics with leachable biocides are effective anti-microbial surfaces, but their toxicity is a major concern. This study provides a fabrication methodology for non-leachable PP-based anti-microbial surfaces that are potentially safer. In addition, this strategy can be extended to many other plastics substrates.

Keywords : anti-microbial activity, E. coli K-12 MG1655, copper (II) chloride dihydrate, magnesium hydroxide, leachable, non-leachable, compounding, thermal embossing
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