Sustainable earthen plasters: how ammonium-based polymers improve their water resistance

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Résumé :

In a world facing growing environmental challenges, earthen constructions offer a sustainable and eco-friendly alternative to conventional building materials. However, their vulnerability to water significantly limits both their durability and broader public acceptance. Biopolymers, especially polysaccharides, have emerged as promising green additives for enhancing the durability of raw earth materials, and their incorporation into eco-compatible earthen mixtures has been widely studied [1]. Nevertheless, despite advances in this field and their consistent effectiveness in mechanical reinforcement, results regarding water resistance remain inconsistent.

The efficacy of ammonium-based compounds in inhibiting clay swelling, thereby improving resistance to hygrometric variations has been demonstrated [2,3]. Therefore, our project focused on studying ammonium-based polymers, some of which are biobased, for the formulation of eco-compatible and durable earthen plasters. Specifically, we investigated the inhibition of clay swelling using model montmorillonite pastes in the presence of polyethyleneimine, chitosan, or ε-polylysine. The oligomeric forms of these molecules proved particularly effective in inhibiting swelling, as shown both at the crystalline scale by measuring basal spacing variations in montmorillonite under controlled humidity, and at the macroscopic scale using Dynamic Vapor Sorption (DVS) with an integrated camera (Figure 1).

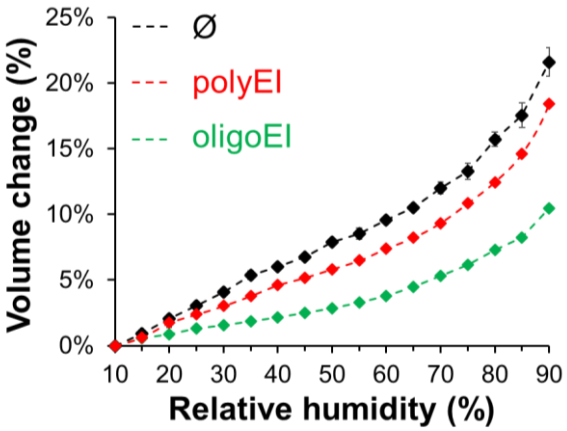

Figure 1. Volumetric swelling (DVS, adsorption regime) of cylindrical samples of untreated montmorillonite (Ø) and montmorillonite treated with branched polyethyleneimine (4.6 wt%), featuring chains of different molar masses: polyEI (M_n = 10,000 g/mol, M_w = 25,000 g/mol) and oligoEI (M_n = 600 g/mol, M_w = 800 g/mol)

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