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Nanoindentation and Microscopic Studies of Calcium Silicate Hydrate-Poly(Vinyl Alcohol) Nanocomposite Materials

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Abstract – In this work C-S-H was synthesized by precipitation, with the addition of organic polymers of PVA, aimed at evaluating the possibility of intercalation in its nanostructure for the fabrication of C-S-H/polymer nanocomposites. To achieve this, C-S-H were synthesized with C/S ratios of 0.7 and 0.8. Synthesis of C-S-H/polymers was characterized by X-Ray diffractometry (XRD), Fourier transform infrared spectroscopy (FT-IR), transmission electron microscopy (TEM) and the mechanical properties through nanoindentation. The PVA polymer proportioned alterations in the nanostructural bonding of C-S-H, influencing the interplanar distance and the type of bonding in the dreirketten and wollastonite regions and in your properties nanomechanical.

Hydrated cement paste, composed mostly of a calcium-silicate-hydrate (C-S-H), is a crystalline semi-continuum material similar to tobermorite crystal, with a complex structure, principally in relation to bonding forces – it is intrinsically fragile with a low flexural strength. The complex nanostructure of C-S-H makes it an excellent candidate for the manipulation and control of its properties, through the intercalation of organic molecules, for the fabrication of C-S-H/polymer nanocomposites.

Figure 1 shows that modification occurred in the interplanar distance after the addition of PVA to the C-S-H produced with a C/S (CaO/SiO_2) ratio of 0.8, thus revealing that there is evidence of intercalation of PVA into the basal plane [002], coincides with the interplanar distance observed by Matsuyama & Young [1] and Mojumdar & Raki [2]. Analyses of the carbon content revealed an increased from 1.10% in pure C-S-H to 14.32% for C-S-H/PVA. In the figure 2, the reduction of the Young's modulus can be observed of approximately 19 GPa of C-S-H for 6 GPa (in 2mN) of the C-S-H/PVA, indicating the alteration nanostructural. In the figure 3, the polymeric film can be observed formed by PVA in the microstructure, and in the figure 4 and 5 the alteration can be verified by TEM, in the nanostructure formation of the C-S-H/PVA - observing the presence of the polymer (figure 4) -, if compared the nanostructure of C-S-H, in figure 6.

This investigation introduces new routes for developing cement-based nanocomposites materials with polymers for future potential applications in the construction field.

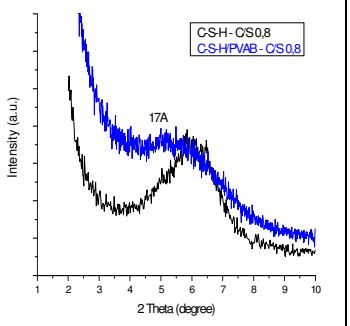

Figure 1: XRD C-S-H/PVA

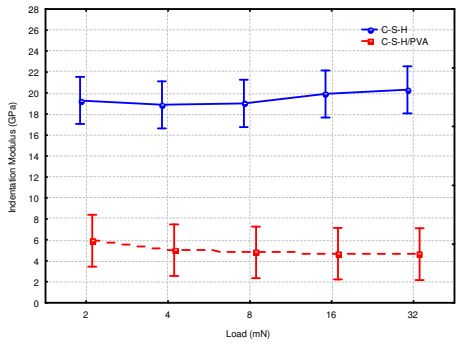

Figure 2: Nanoindentation C-S-H and C-S-H/PVA

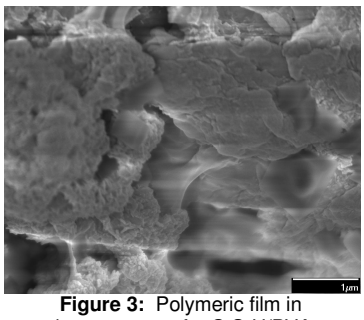

Figure 3: Polymeric film in microstructure of a C-S-H/PVA.

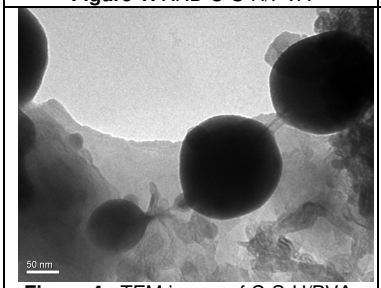

Figure 4: TEM image of C-S-H/PVA.

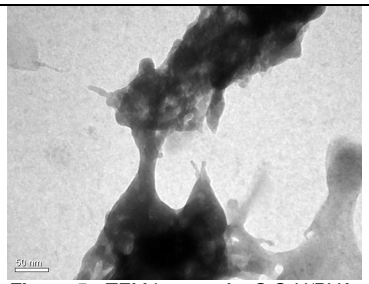

Figure 5: TEM image of a C-S-H/PVA.

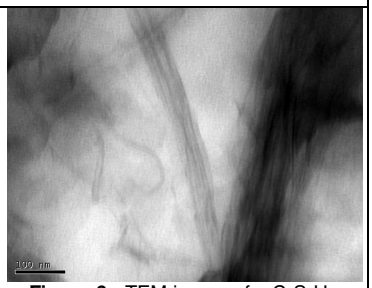

Figure 6: TEM image of a C-S-H.

References

[1] H. Matsuyama and J.F. Young. Journal of Materials Research. 14 (1999) 3379-3388.
[2] S.C. Mojumdar and L. Raki. Journal of Thermal Analysis and Calorimetry. 82 (2005) 89-95.