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Biopolymers -2016: Radiation Processed Textile Sludge for Preparing Eco-friendly Bricks

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Textile mill, the largest revenue earning industry in Bangladesh is facing problem with the disposal of its solid waste (sludge). In this study, textile sludge is detoxified with gamma irradiation (15 kGy) and then used to make environmental friendly bricks for construction purposes. Bricks were graded based on the sludge and clay content ratio. Sludge was mixed with clay and bricks were made in wooden frame. Dried brick samples were then kept at 450°C for 24 hours in furnace. Controlling the temperature allowed us to produce the brick without producing any NOx. Parameters such as density (g/cm³), weight loss (%), firing shrinkage (%),bending strength (MPa), , Bending modules (MPa), Impact strength (kJ/m²), water uptake (%) and electrical resistivity (Ω-m) were investigated. Density, weight loss, firing shrinkage and electrical resistivity reduced as sludge content (%) in bricks increased whereas bending strength, Bending modules, Impact strength and water uptake (%) increased with the increase of sludge content. The optimum results were found for the 50-50% sludge/clay samples. Further increase in the sludge percentage led to loss of strength and compactness of the brick sample. According to the results, the optimum sample showed higher strength than the sample made by pure clay; but showed slightly lower strength than the commercial brick. The change in density of all bricks was experienced during the aging tests in water, acid, alkali and salt. bending strength, Bending modules, Impact strength were also tested for water and acid aging. Morphological analysis of the brick samples were done by metallurgical inverted microscope.

In the construction industry, nanotechnology could potentially improve many building systems and explain some materials properties. Cement based materials are built up from the complex and complicated nanoscale structure of cement and its hydrates and, in several systems these "nano-effects" determine all the "macro-scale" properties that are usually measured1. On the idea of recent molecular simulation and experimental studies, possible strategies for tuning the mechanical properties of cementitious materials by modifying the bonding scheme within the hydrates at molecular level are being discussed2. On ceramic tile systems it is not different. The overall results of adherence between ceramic tiles and polymer modified mortars might be explained considering the nano-order structure that's developed at the interface tile/mortar3.

Latex modified Portland cement mortars based on poly(ethylene-co-vinyl acetate), EVA, is the standard product in the market for ceramic tile installation4. However, based on chemical features of EVA and ceramic tiles, predominantly the weak van der Waals forces are expected to be developed at the tile-polymer modified mortar interface. On the other hand, surface modification is generally performed to modify its properties such as enhancing the interface adhesion between inorganic and organic materials. In this sense, silane coupling agents have been used for generating a hybrid (organic-inorganic) layer onto substrates5.

Hence, the main goal of this work was to promote a novel chemical functionalization of ceramic tiles surfaces by modifying with trialkoxysilanes coupling agents to generate an organic layer onto inorganic tile so as to reinforce the interface adhesion between tile and polymer modified mortar.

Soda-lime glass tiles ($SiO_2 \approx 70$ wt. (%); $Na_2O \approx 15$ wt. (%); $CaO \approx 10$ wt. (%)) with dimensions of fifty x 50 mm were selected to be used as template for modeling the effect of silane modification within the adherence between EVA modified mortar and silane modified tile. This choice was supported the chemical similarity of glass tile compared to ceramic tile related to the vitreous phase and composition for mimetizing inorganic substrate properties.

Glass tile surfaces were prepared with five silane derivatives bearing specific functionalities. Amino (-NH_2), mercapto (-SH), vinyl (-CH = CH_2), methacrylic (CH_2 = C(CH_3)COO-), and isocyanate

(-N = C = O) groups were chosen as reactive groups of coupling agents (Table 1) for evaluating their relative compatibility with the EVA mortar. The silanes were supplied by Sigma-Aldrich. Glass tile without any chemical modification (as supplied) was used as reference.

Prior to silane reaction, glass tile surface impurities were fully removed by immersion in 20% nitric acid for 2 hours, followed by deionized water (DI) rinse. After that, tiles were overnight dipped in DI water and air dried.

Hydroxylation (-OH) was conducted by soaking tile samples in a 70:30 mixture of deionized water: 30% hydrogen peroxide (H2O2) for 45 minutes at about 70 °C. Then, 5 mL of NH4OH (conc.) were dropped for each 100 mL of the H2O:H2O2 solution. After cooling, glass tile was rinsed in DI water and then dried in methanol. This increase of hydroxyl concentration is usually recommended and performed before silane application. This process enhances the density of available sites for silane reaction, improving surface modification process. Hydroxyl functionalization of glass results in the increase of silanol groups (Si-OH) at tile surface related to the reaction of silicon incomplete bonds minimizing free energy. The effect of this hydrophilic chemical functionalization with silanol groups within the adherence between EVA modified mortar and glass tile was also evaluated.