Novel graphene/TiO_2 embedded in photocatalytic surfaces for environmental remediation.

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The design of new photocatalysts (PCs) that use effectively solar light to eliminate organic[1]/noxious inorganic(NOx)[2] air pollutants (when integrated into smart surfaces[3]) is a hot topics for research for the worldwide environmental problem. PCs based on TiO_2 anatase nanoparticle (TiO_2-NP)[4] are heavily used in the construction sector that already accounts for ~90% of the market of PCs[5] with figures that are projected to grow from nearly $1.4 billion in 2015 to 2.6 billion in 2020[5]. TiO_2-NPs have the advantages of low cost (1.9K USD/t at 2016 prices[6]) and stability[7]. However, as a major drawback, TiO_2 can be activated only by a minor fraction of the solar light (the UV component) because of its high band gap ($\Delta E \approx 3.25$ eV[7]). Although TiO2 photoactivity can be enhanced with graphene (GR-PCs) the application in the cementitious matrix has some key issues: i) the embedment is detrimental for the photoactivity of the PCs; ii) the increase of cost must be limited as concrete is a cost-driven material. Here we report scalable processes for the preparation of low cost PCs with enhanced photocatalytic activity also in cementitious matrix. We refer to scalable processes for low cost G-PCs (produced by ball milling[8], i.e MCG, and by shear mixing[9], i.e LAG10. Characterization by XRD, SEM-EDX, micro-Raman, HR-SEM etc was carried out. The photoactivity of PCs, in powder form as well as embedded in cementitious matrix, was tested by NOx abatement (UNI11247) and by dye (i.e Rhodamine) degradation. With respect of pristine TiO_2, LAG 10 and MCG showed an enhanced NO_X abatement and pollutant degradation rate as well of two digits.

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