Incorporation of nio into sio_2, tio_2, al_2o_3, and $na_{4.2}ca_{2.8}(si_6o_{18})$ matrices: Medium effect on the optical properties and catalytic degradation of methylene blue

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Abstract
The medium effect of the optical and catalytic degradation of methylene blue was studied in the NiO/SiO_2, NiO/TiO_2, NiO/Al_2O_3, and NiO/$Na_{4.2}Ca_{2.8}(Si_6O_{18})$ composites, which were prepared by a solid-state method. The new composites were characterized by XRD (X-ray diffraction of powder), SEM/EDS, TEM, and HR-TEM. The size of the NiO nanoparticles obtained from the PSP-4-PVP (polyvinylpyrrolidone) precursors inside the different matrices follow the order of SiO_2 > TiO_2 > Al_2O_3 . However, NiO nanoparticles obtained from the chitosan precursor does not present an effect on the particle size. It was found that the medium effect of the matrices (SiO_2, TiO_2, Al_2O_3, and $Na_{4.2}Ca_{2.8}(Si_6O_{18})$) on the photocatalytic methylene blue degradation, can be described as a specific interaction of the NiO material acting as a semiconductor with the M_xO_y materials through a possible p-n junction. The highest catalytic activity was found for the TiO_2 and glass composites where a favorable p-n junction was formed. The isolating character of Al_2O_3 and SiO_2 and their non-semiconductor behavior preclude this interaction to form a p-n junction, and thus a lower catalytic activity. NiO/SiO_2 and NiO/$Na_{4.2}Ca_{2.8}(Si_6O_{18})$ showed a similar photocatalytic behavior. On the other hand, the effect of the matrix on the optical properties for the NiO/SiO_2, NiO/TiO_2, NiO/Al_2O_3, and NiO/$Na_{4.2}Ca_{2.8}(Si_6O_{18})$ composites can be described by the different dielectric constants of the SiO_2, TiO_2, Al_2O_3, $Na_{4.2}Ca_{2.8}(Si_6O_{18})$ matrices. The maxima absorption of the composites (λ_{max}) exhibit a direct relationship with the dielectric constants, while their semiconductor bandgap (E_g) present an inverse relationship with the dielectric constants. A direct relationship between λ_{max} and E_g was found from these correlations. The effect of the polymer precursor on the particle size can explain some deviations from this relationship, as the correlation between the particle size and absorption is well known. Finally, the NiO/$Na_{4.2}Ca_{2.8}(Si_6O_{18})$ composite was reported in this work for the first time.

Author keywords
Chitosan
Nickel oxide
Optical properties
Photocatalysis
Polyvinylpyrrolidone