Preparation of glycine–modified silica nanoparticles for the adsorption of malachite green dye

Abstract

Organo-functionalized silica nanoparticles were prepared using an in situ modified sol–gel process (hydrolysis–esterification–condensation). This was accomplished under basic conditions by the addition of glycine as a modifier. Evidence of glycine presence was supported by Fourier Transform Infrared (FT-IR) spectroscopy and thermogravimetric analysis (TGA). The addition of 10 wt% glycine into the silica precursor (tetraethoxysilane), in ethanol or methanol media, resulted in a small particle size with a narrow particle size distribution and a high surface area. This is known as a mesoporous structure with a high adsorption volume. Adsorption behavior of the glycine-modified silica nanoparticles was then investigated using a malachite green (MG) dye. Adsorption capacity was raised by increasing the amount of glycine modified silica, MG concentration, and contact time. The Langmuir adsorption isotherm gave the best fit to the experimental data, suggesting monolayer adsorption on a homogenous surface. Adsorption kinetics were predicted by the pseudo-first order kinetic model rather than the pseudo-second order kinetic model, in which the values of adsorption capacity between the theoretical and experimental were more consistent.