

Assessment of hexavalent chromium interaction with Magnesium/Aluminum nitrated layered double hydroxide nanoparticles

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Hexavalent chromium (Cr (VI)) is a hazardous substance. Since 1991, the US Environmental Protection Agency has established an upper limit contamination level of 100 ppb for total chromium in drinking water [1]. Layered double hydroxide (LDH) is one of the promising materials eliminating the water contaminants due to the high anionic exchange capacity [2, 3].

This research aims to synthesize nanoparticles of Al-Mg LDH intercalated with nitrate to understand the interaction between LDH and Cr(IV) based on spectroscopy and analytical measurements.

The LDH nanoparticles were produced utilizing a fast co-precipitation process assisted by hydrothermal treatment and characterized by a variety of characterization techniques (PXRD, Raman and IR spectroscopy, BET, SEM, Zeta potential, DLS and ICP). Various steps of the synthesis were adjusted to reduce the leaching of Mg and the formation of Gibbsite ($\text{Al}(\text{OH})_3$). The effects of those steps will be discussed.

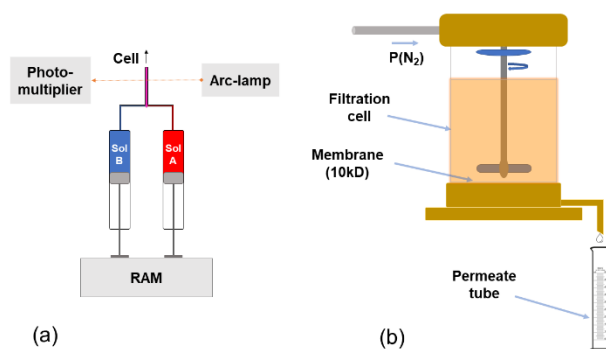


Figure 1. (a) Stopped-flow device and (b) ultrafiltration method assembly.

The adsorption of Cr(VI) was studied from both the thermodynamic and the kinetic points of view. Firstly, the stopped flow technique allowed to study the kinetics of adsorption of Cr(VI) on colloidal LDH nanoparticles. It is based on the observed change in absorbance during the adsorption. It allowed to distinguish two steps, an extremely fast one and a slower one. with a stopped-flow device at various LDH and Cr(VI) concentrations. The absorbance of the solution changes. The extremely fast step which takes place within the first milliseconds can be attributed to a surface adsorption driven by the strong electrostatic interaction ($\zeta \sim +50$ mV). The second step, the absorbance keeps evolving for at least 40 minutes at pH = 4 showing that the reaction which continues could be attributed to an internal rearrangement. This spectrophotometric study also gives some insights on the Cr(VI) protonation state once adsorbed. This was done in two distinct pH media to compare the two primary forms of Cr (IV) in solution, HCrO_4^- and CrO_4^{2-} . Secondly, the ultrafiltration technique was used to determine the efficiency of Cr(VI) removal from the initial solution. After 7 minutes, the decontamination efficiency was examined in the range of Cr(VI) [2.5-12.5 mg/L] and achieved more than 99% with a concentration of 0.25 g/L of LDH. The ultrafiltration allowed at the same to characterize the loss of LDH contents during the sorption process and to recover the LDH solid containing Cr(VI) which was characterized in order to investigate the structural and chemical modifications caused by this interaction.

References:

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