EFFECT OF SURFACE CHEMISTRY OF *BENTONITE/Mg,Fe–LDHs* COMPOSITESONTHE IMPLICATION FOR ENVIRONMENTAL REMEDIATION

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There is demand for improving the adsorption processes for watertreatments, these is motivated of researchers to identify novel low cost and sustanbility adsorbents with high sorption capacity for a wide range of toxic contaminants.In particular, clay materials such as bentonite have beenintensively studied, due to their characteristic properties, such as cation exchange capacity,low cost, and eco-friendliness. The Layered Double Hydroxides (LDHs) are also called 'anionic clays' due to the structural similaritieswith clay minerals. Owing to the presence of exchangeable anions inthe interlayer space, LDHs possess excellent properties in terms of anionsremoval from aqueous solutions.Generally, theLDHs which have a formula $[M^{2+}{}_{1-x}M^{3+}{}_{x}(OH)_2]^{x+}[(x/n)\ (A^{n-})\cdot mH_2O]^{x-}$, where M^{2+} are divalent cations, M^{3+} are trivalent cations, x is the $M^{2+}/(M^{2+}+M^{3+})$ ratio and A^{n-} is the exchangeable interlayer anion of valence n, as demonstrated in Fig. 1.

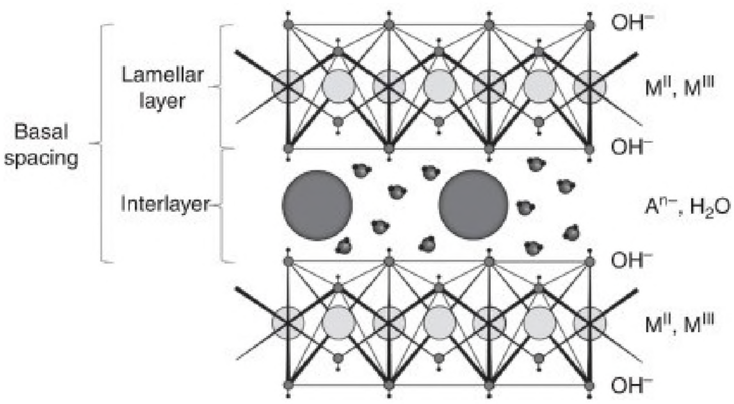

Fig. 1 The structure of syntheticclays such as LDHs [2]

Due to it is structure, these materials have a high customization possibility, environmental friendliness, advantages of relatively simple preparation, and low cost. A lot of the mentioned papers discuss mostly Mg,Al- and Ca,Al-bearing LDHs, as synthetic analogues of the most widespread hydrotalcite. To prevent the possible side effect and enhance the characteristic properties of LDHs, the use of a modification with various support materials such as magnetite, biochar, graphene and natural clay [1].

In this work, *Ben@Mg,Fe-LDHs* composite material was effectively produced here by drawing upon the facile in-situ co-depositionmethod various. *Ben@Mg,Fe-LDHs* with different Mg,Fe-LDHs/bentonite ratios and different interlayered anions were synthesized. The effects of synthesis conditions, such as the molarity of metals, coexisting anionic type, temperature, reaction period, and pH has studied. Furthermore, the obtained composites have been characterized usingvarious solid-state characterization techniques mostly by X-Ray Diffraction (XRD), Scanning electron microscopy (SEM) and Fourier Transform Infrared Spectroscopy (FTIR). Eventually, the relationship between the structural properties of *Ben@Mg,Fe-LDHs* composite and their adsorption performances is revealed.

The morphologies and states of the starting *Mg,Fe-LDHs* and *Ben@Mg,Fe-LDHs*, and the SEM images are illustrated in Fig. 2. The *Mg,Fe-LDHs* is characterized bystacked LDH layers, containing big particles shaped irregularly and agglomerates. According to Fig. 2b, the SEM imagei of *Ben@Mg,Fe-LDHs* demonstrates that the adsorbent comprisesconsiderable uniform structures and stacks in thec-direction to form loose shape agglomerates, which havea more exposed surface.According to EDX spectra, the main chemical composition of bentonite was Si, Al, and O elements, while *Mg,Fe-LDHs* primarily comprised Fe, Mg, O, N, and Cl. The EDX spectra shows that *Mg,Fe-LDHs* was uniformly loaded on bentonite.

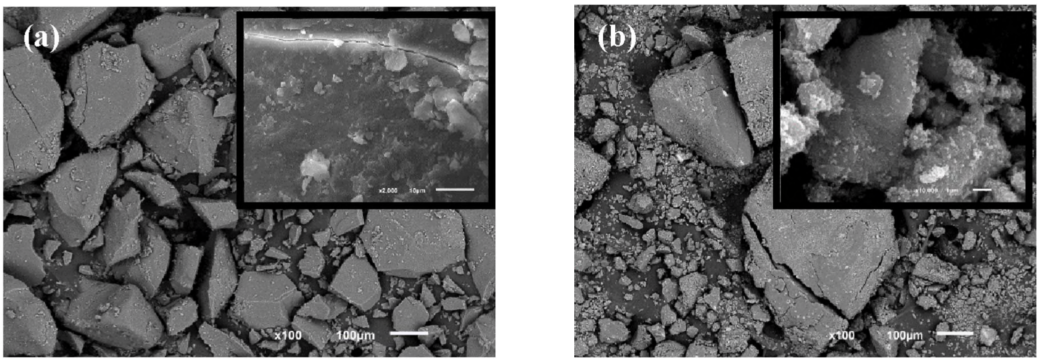

Fig. 2 SEM images of obtained *Mg,Fe-LDHs* (*a*) and *Ben@Mg,Fe-LDHs* (*b*) compositeswith various magnifications (*inset pictures*)

The XRD pattern of *Mg,Fe-LDHs* sample represented peaks at d_{003}, d_{006}, d_{015}, d_{012}, d_{110} , and d_{113}, separately, and the pattern of *Ben@Mg,Fe-LDHs* indicated peaks of bentonite and *Mg,Fe-LDHs*, thereby showing *Ben@Mg,Fe-LDHs* composite has been obtained. The bands at 510 cm^{-1} in the FTIR spectra of natural clay and *Ben@Mg,Fe-LDHs*samples were due toAl–O–Si bending vibrations. According to the FTIR spectrumof bentonite, a weak band under 795 cm^{-1} and 838 cm^{-1} represented the Fe–O and Mg-O bonds, respectively, thereby revealing that bentonitehas considerable Mg and Fe. The extreme absorption band at1034 cm^{-1} belonged to Si–O bending vibration, *Ben@Mg,Fe-LDHs* also had this absorption band means *Mg,Fe-LDHs* loaded on bentonite. The 3450 cm^{-1} and 1641 cm^{-1} band sbelonged to the OH frequencies of the water molecule. Theband belonging to Al–OH was identified at 3625 cm^{-1}. The band at 709 cm^{-1} was correlated with whether interlayer carbonate was present. The FTIR spectra revealed bands in the regionof 1540–1350 cm^{-1} indicating the presence of intercalated CO_3^{2-} anions, which was the result of the reaction with aCO_2 in the solution during the synthesis.

The maximal adsorption capability of *Ben@Mg,Fe-LDHs* toward Ni(II) and Pb(II) ions can reach to ~200.0 mg/g and 600.0 mg/g, respectively, exceeding those of conventional individual components of composite at pH ~7.0. The adsorption mechanisms of *Ben@Mg,Fe-LDHs* demonstrating that there may exist surface complexation, ion exchange, and chemical deposition between *Ben@Mg,Fe-LDHs* and heavy metals. The heavy metal ions adsorption capacities increase with increasing the Mg,Fe-LDHs/bentonite ratio in *Ben@Mg,Fe-LDHs* samples. Thus, as-prepared *Ben@Mg,Fe-LDHs*-based samples are expected to be a new adsorbents for the removal and recovery of pollutants from aqueous environments.

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