

Hybrid Layered Double Hydroxide With Biopolymers : A Potential Controlled Release Phosphate Fertilizer

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With increasing global population and extreme weather caused by climate change, ensuring sufficient food production, i.e. food security, has become an urgent and critical issue. The phosphorus (P) is one of essential macronutrients for plant growth. Conventional farming usually applies excessive phosphate fertilizers; however, only about 15 percent of phosphate fertilizer is taken up by plants. The rest phosphate fertilizer usually flows into water system leading to eutrophication. Moreover, P reserves are limited and unevenly distributed on the earth and it is a non-renewable resource. For that reason, P would become a limiting factor for food production and P production will peak around 2033, after which demand will exceed supply. Therefore, the goal of this project is to develop environmentally friendly and slow-release phosphate fertilizers. This study used nature polymers including chitosan (CTS) and carboxymethyl cellulose (CMC) to synthesize LDHs. From the XRD results, we confirmed that hybrid LDHs synthesis was successful. Besides, the observed maximum adsorption capacity for phosphate of hybrid LDHs were from 57.89 to 65.01 mg/g, which showed the outstanding ability to absorb phosphate. However, after the phosphate loading on the carriers, the LDH structure was destroyed due to the magnesium dissolution. Nevertheless, compared with other carriers, the materials could still release phosphate up to 32.25% and constant for more than 2688 h. The linear combination fitting (LCF) analysis showed that phosphorus species percentage were changed not only at different desorption time but also at different polymers ratio. From the P species, we could presume the release rate is related to the exchangeable phosphate. Especially in 0.5 ratio samples, the exchangeable phosphate ratio kept at an almost steady percentage during release time. It meant that exchangeable form could keep releasing and the Fe-P form would transform into exchangeable form at same time. The Fe-EXAFS results indicated the structure of the hybrid LDHs weren't same because they showed the different signal at Fe-O bond and Fe-Mg bond. That was also one of the reasons that different polymer ratio caused the distinct release mechanisms.