Functionalized clay-based hydrogel composites for agricultural applications

FX Perrin, Y Elhadj

Laboratoire Matériaux Polymères Interfaces Environnement Marin (MAPIEM EA 4323), 4 Université de Toulon CS 60584 - 83041 TOULON CEDEX 9 – France

E-mail address: perrin@univ-tln.fr (FX Perrin)

In agriculture, two key factors essential for plant growth are an adequate supply of water and fertilizer. Therefore, enhancing the efficiency of water and nutrient fertilizer use is crucial. A key goal in agronomic management is improving fertilizer use efficiency by reducing its environmental loss. One approach to achieving this is the use of slow or controlled release fertilizer (SRF) systems, which help minimize fertilizer losses and boost its efficiency. First, we will discuss the formation of composite hydrogels, which are prepared through in situ polymerization of acrylic acid and acrylamide (using an organic co-crosslinker), and incorporate either a clay-urea intercalate or separate clay and urea into the reaction medium. We will see that clay-urea intercalates can be prepared quickly (within 15 minutes) through mechanochemical grinding using a planetary ball mill, with minimal amorphization of the clay[1]. The two preparation methods for the hydrogel composites resulted in noticeable differences in swelling behavior, water retention, and urea release kinetics. Composites made with clay-urea intercalates exhibited superior water retention compared to those made by simple mixing, primarily due to the more uniform dispersion of kaolinite, which created a more tortuous path for water molecules. Additionally, urea release from hydrogel composites with clay-urea intercalates was slower than from those prepared by the one-step method. In the second part of the presentation, we will explore how it is possible to functionalize clay to facilitate the polymerization of the acrylic monomer on its surface, resulting in a gel-like structure at room temperature without the need for an additional organic co-crosslinker. The hydrogels obtained in this way are both flexible and tough, with good elastic recovery properties, making them suitable for withstanding a large number of swelling-deswelling cycles.

[1] Y Elhadj, FX Perrin, Appl Clay Sci, 213, 106250, 2021.