NATURAL CELLULOSE COATED DISPERSIONS: NEW OPPORTUNITIES IN GREEN PROCESS ENGINEERING AND APPLICATIONS

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Our recent discoveries have shown that cellulose chains could be molecularly dissolved in a solvent mixture of an ionic liquid with certain polar organic solvents, forming true solutions. Due to their molecular dissolution, the cellulose chains in hydrogels, formed by regeneration of these solutions, are also maintained in an amorphous structure. Furthermore, as was reported recently, cellulose solutions in other solvents, as well as suspensions of cellulose hydrogel particles, can be used as a novel amphiphilic coating for oil/water emulsification, by utilizing cellulose as an encapsulating agent that forms a stabilizing coating in oil-in-water and water-in-oil emulsions without the use of additional surfactants. Our innovative encapsulation process is cheap, “green” and uses simple fabrication methods (1-5).

We have studied cellulose dissolution, formation and structure of regenerated cellulose hydrogels and fragmented hydrogel dispersions. Furthermore, we studied the influence of fabrication processes on structural parameters of cellulose coated oil-in-water emulsions, as well as their enzymatic degradation.

We hypothesize that hydrophobic regions of the cellulose chain adhere to the oil surface whereas its hydrophilic regions will interact with water molecules. Thus, specifically oriented cellulose molecules coating on emulsion particles are formed. These assumptions are supported by results of molecular dynamics simulations.

We discovered a major enhancement of the enzymatic hydrolysis rate of cellulose coating such emulsified oil droplets. It is hypothesized that this effect is due to the large surface area available to enzymes in cellulose-coated emulsions, as well as their porosity and molecular orientation of cellulose chains on the oil surface. Microscopy images exhibited a unique feature due to enzymatic etching of cellulose covered oil-in-water emulsion drops: formation of a regular porous membrane-like shell on the surface of the emulsion particles. These effects present new opportunities in intensification of cellulose enzymatic hydrolysis and controlled etching processes; a new sustainable energy manufacturing process combining fabricating of saccharides, alcohols and biofuels; as well as synthesis of novel carriers of hydrophobic materials (e.g. controlled release of pharmaceutical of cosmetic molecules).

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