הטכניון - מכון טכנולוגי לישראל

TECHNION - ISRAEL INSTITUTE OF TECHNOLOGY

הפקולטה להנדסה כימית
ע"ש וולפסון
The Wolfson Department of Chemical Engineering

Wolfson Department of Chemical Engineering Special Seminar
Lecture Hall 6, Wolfson Department of Chemical Engineering,
Wednesday August 1st at 10:30 am

Sofia Napso

Ph.D. Student (Advisors: Prof. Yachin Cohen and Dr. Dmitry Rein), Chemical Engineering, Technion

CELLULOSE-COATED OIL-IN-WATER EMULSIONS

Cellulose is the most abundant renewable biopolymer on earth, yet only a minute fraction of its annual natural production is utilized as a raw material for fabrication of synthetic products, or as a source for biofuel. Its processing requires harsh solvents or procedures considered to be detrimental to the environment and are increasingly regulated. Ionic liquids (IL) are powerful "green" solvents capable of dissolving cellulose for further processing. Solutions of cellulose in an IL and its mixture with a polar organic co-solvent were studied by small-angle x-ray scattering (SAXS), to evaluate the structure and thermodynamic solution properties, providing direct evidence of molecular dissolution of the cellulose chains without any significant aggregation. Furthermore, the dissolved cellulose chains or the amorphous cellulose hydrogel regenerated from such solution readily form a unique encapsulation coating in oil-in-water (o/w) emulsions. The structure of these cellulose-coated o/w emulsion particles, in particular the cellulose coating shell characteristics (thickness, porosity and composition), was studied by using a combination of direct imaging methods, cryogenic electron microscopy (cryo-EM) and fluorescence microscopy with quantitative analysis using small-angle neutron scattering (SANS) measurements. This work suggests a new kind of emulsion particle: an oil core, surrounded by an inner shell composed of a porous cellulose gel, encapsulated by a dense outer cellulose shell, a few nanometers in thickness. The suggested multi-compartment structure of the emulsion particles is highly relevant for applications ranging from fabrication of polymer-coated capsules for health-care and nutrition products to micro-reactors for cost-effective biofuel processing.

Gilad Alfassi

Ph.D. student (Advisors: Prof. Yachin Cohen and Dr. Dmitry Rein), Chemical Engineering, Technion

PROCESS FOR ENZYMATIC DEGRADATION OF CELLULOSE

This research focuses on an economically viable technology for waste or non-food biomass (cellulose) hydrolysis, thus providing a sustainable pathway for ethanol production. Today, the production of cellulosic bio-fuels is not fully utilized mainly due to costs of conversion. To address this problem, the structure of the cellulose chains was engineered to provide the best environment for enhanced enzymatic hydrolysis. This was done by creating an amorphous regenerated cellulose dispersion followed by fabrication of emulsion particles, where the oil phase is coated by the cellulose hydrogel. The supramolecular cellulose structure was modified and its effect on enhancing cellulose hydrolysis was evaluated.

The results show significant improvement in glucose production when the cellulose hydrogel is dispersed on a micro-scale, as compared to larger hydrogel particles. Furthermore, the ability of the enzyme to attack the cellulose shell on the surface of an oil droplet was described for the first time, introducing cellulose-coated oil-in-water emulsion droplets as a novel substrate for cellulose hydrolysis. This may be also relevant for advanced cellulose conversion processes, such as in the simultaneous extraction of reaction products and/or esterification. Another improvement was achieved by a novel chemical modification process of the cellulose chains, using an ionic liquid mixed with dichloromethane. The modification process was characterized and its mechanism was suggested. This benign modification results in cellulose solubility in water followed by an overwhelming increase in hydrolysis rate – 70% of the cellulose is degraded in less than 5 minutes. These results provide a significant improvement toward bio-ethanol production from non-food biomass.

Refreshments will be served at 10:15 am