LIGHT-DRIVEN ENZYMATIC DEGRADATION OF LIGNOCELLULOSE

K.Benedikt Möllers[a,b] and David Cannella[a*], Niels-Ulrik Frigaard[b], Pouk Erik Jensen[c], Morten Jannik Bjerrum[d], Katja Salomon Johansen[c] and Claus Felby[a]*
*[a]Department of Geosciences and Natural Resource Management, University of Copenhagen, Frederiksberg C, Denmark, [b]Department of Biology, University of Copenhagen, Helsingør, Denmark, [c]Chalmers University of Technology, Goteborg, SC, Sweden, [d]University of Copenhagen, Copenhagen, Denmark, *equally contributing first authors*
E-mail: kbm@ign.ku.dk

Nearly all life on Planet Earth depends on solar energy. A tiny fraction of this energy is captured into our biosphere by photosynthesis which results in the generation of organic carbon via reduction of CO_2. A similar process might as well be important for carbon oxidation. Recently, we discovered of a new light-driven enzymatic pathway for oxidation of organic carbon which consists of a photosynthetic pigment, i.e. thylakoids or modified chlorophyllin, and a lytic polysaccharide monooxygenase (LPMO). LPMOs are powerful and widely distributed oxidative enzymes, usually employed by fungi and bacteria to decompose recalcitrant lignocellulosic biomass. These enzymes require an external donor of electrons, which we have found can be in the form of an excited electron from photosynthetic pigments, such as chlorophyllin or thylakoids.

Our results show that light-induced electron transfer (LIET) from the excited pigment to the electron-accepting enzyme can not only successfully oxidize cellulose but furthermore, enhance the catalytic activity of LPMOs 100-fold. In addition the substrate specificity is broadened to include both cellulose and hemicellulose.

For potential applications, synergistic effects between the LIET-LPMO system and commercially available cellulases are highly appreciated. Therefore, mono-component CBHs I and II and a β-glucosidase were tested in combination with the LIET-LPMO system. Besides strong synergistic effects for CBHs + LIET-LPMO, other important factors for the application of LIET have been identified and will be presented and discussed.