Prof. Jeremy Luterbacher

Ecole polytechnique fédérale de Lausanne

After atmospheric carbon dioxide, lignocellulosic biomass is the second-largest source of renewable carbon on our planet. This makes biomass a very attractive source of sustainable alternatives to fossil-derived chemicals. The production of various chemicals from biomass usually involves the depolymerization of biomass's three constituent polymers: cellulose and hemicellulose, which are both polysaccharides; and lignin, which is a polymer of phenyl propanoid sub-units. These three types of complex molecules are broken down into their constituent monomers, which include sugars and phenyl propane derivatives. In turn, these low-molecular weight monomers can be catalytically upgraded to either direct or indirect substitutes for petrochemicals. In both depolymerization and catalytic upgrading, the biggest challenge is usually not achieving the desired reaction, but rather avoiding being outcompeted by other, detrimental reactions. Depolymerization reactions of the major biomass constituents – polysaccharides and lignin – are often outpaced by subsequent degradation reactions of sugars and lignin intermediates. Degradation is especially pronounced during lignin extraction which has systematically prevented its successful upgrading to chemicals.

Jeremy Luterbacher and his research group have discovered that the use of functionalization with acetals, both during lignin extraction and polysaccharide depolymerization, can reversibly "trap" stabilized intermediate molecules, and facilitate their high-yield upgrading. Notably, they have shown that under the right conditions, extracted lignin, which is normally very difficult to utilize, could be catalytically upgraded at high yields to as few as one or two major products. This particular chemistry has the potential to greatly enhance the productivity of biorefineries and pulp and paper processes.