LOW-COST IONIC LIQUIDS FOR LIGNOCELLULOSE DECONSTRUCTION

Jason Hallett, Agnieszka Brandt
Imperial College London
Department of Chemical Engineering
London, UK
j.hallett@imperial.ac.uk

One of the key challenges in biorefining is the initial separation or deconstruction of lignocellulosic components, and ionic liquids (organic salts) offer unique advantages in this area, due to their unusual thermochemical properties. Previous IL-based biomass research has focused on swelling and dissolving the entire lignocellulose with dry ILs. The requirement for costly ionic liquids has resulted in challenges for IL recovery. Water, a major component of biomass, prevents cellulose dissolution, necessitating extensive drying of biomass and the hygroscopic IL, increasing energy costs. We have overcome this by redesigning the process for lignin dissolution, yielding filterable cellulose, preconditioned for further use, and an IL-lignin solution for precipitation or conversion to high-value chemicals. We use a range of 'protic' ILs, the family typically used in IL industrial processes because their simple acid-base chemistry makes them easy and cheap to prepare. Despite the low cost (as low as \$1.24 per kg)[1] and low environmental impact, solvent recycling is mandatory for this application.[2]

Using these acidic solvents, we have achieved saccharification yields and lignin recoveries of over 90%. This presentation will discuss pretreatment conditions, saccharification yields, pulp quality, lignin characterisation, ionic liquid interactions with the biopolymers, and manufacturing approaches. We have utilised a variety of analytical techniques (e.g. HSQC NMR) and studies involving model compounds for lignin and cellulose in an effort to understand the molecular-scale chemistry and mechanistic events underpinning the observed solution chemistry. The results from this study demonstrate that the ILs maintain solvent stability under long-term processing conditions, that they can be recovered and continue to exhibit very good cellulose lignin fractionation after multiple reuses. This will eventually enable us to identify target compounds and synthesis routes for the valorization of our biomass feedstocks.

[1] L.Chen, M. Sharifzadeh, N. Mac Dowell, T.Welton, N.Shah, J.P. Hallett, Green Chemistry, 2014.
[2] D. Klein-Marcuschamer, B. A. Simmons and H. W. Blanch, Biofuels, Bioprod. Biorefin., 2011, 5, 562–56.