supported ionic liquid silica nanoparticles are excellent heterogeneous catalysts for the dehydration of fructose to 5-hydroxymethylfurfural

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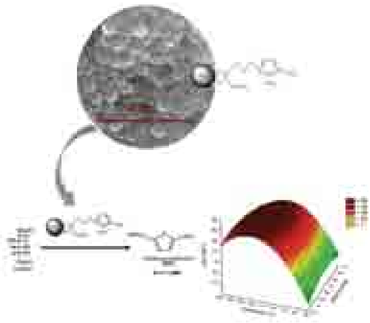
Diminishing fossil fuel reserves and growing concerns about global warming have fostered the development of alternative sources of energy and chemicals. Renewable biomass resources are promising alternatives for the sustainable supply of liquid fuels and chemical intermediates.
The catalytic conversion of biomass is important to develop alternatives to crude oil derivatives. Among the many biomass-derived chemicals, 5-hydroxymethylfurfural (HMF) is a particularly valuable intermediate for fine chemicals, pharmaceuticals and in biofuel and polymer chemistry. Hence, acid catalyzed dehydration of fructose to HMF has received substantial attention. Homogeneous acid catalyzed processes can achieve only up to 90% fructose conversion with moderate HMF yield, and it has severe drawbacks in terms of equipment corrosion, separation and recycling; while existing heterogeneous acid catalysts can be recycled and have high HMF selectivity, but very low fructose conversion even after a very long reaction time. Consequently, more efficient catalytic systems for the selective production of HMF from fructose need to be developed.

At the University of Aveiro researchers from CICECO have recently developed supported ionic liquid nanoparticles (SILNPs) (Green Chem., 2011, 13, 340-349). The SILNPs are composed of amorphous SiO2, each sample characterized by a distinct average particle size (300 to 600 nm) that depends on the ammonia concentration employed in the synthesis by using a sol-gel method.
The silica surfaces have been chemically modified with an ionic liquid via covalent attachment using a silicon alkoxide linker.
The SILNPs are a new catalyst that quickly (less than 30 minutes reaction time), and efficiently (99.9% conversion), convert fructose into HMF with yields of 63% in optimized reaction conditions (130ºC).
These heterogeneous catalysts present improved performances over other zeolites and strong acid ion exchange resin catalysts previously used, and were shown to be efficiently and easily recycled without any significant loss in fructose conversion and HMF yield.
These new catalysts, allowing the conversion of biomass fraction into valuable products, contribute to make the biorefinery dream come true, minimizing our dependency on crude oil derivatives and advancing the world's sustainability.



direct imaging of Joule heating dynamics and temperature profiling inside a carbon nanotube interconnect

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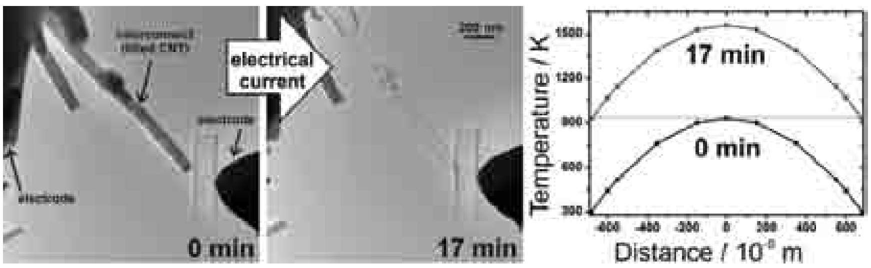

Resistive heating is a common phenomenon when electronic components are exposed to high current densities. It leads to an accentuated waste of energy and favours electromigration, a frequent cause of circuit failure. Knowing how the building blocks of nanoscaled electronic circuits respond to such electrical stress is essential for their future use in devices. Carbon nanotubes (CNTs) have been widely touted as superior wires to connect the various components of next-generation integrated circuits. Despite almost two decades of intense effort, insight into the internal structural and thermal responses of these structures when subjected to resistive heating has been lacking. On the 9th of August 2011, in a report published by Nature Communications (doi: 10.1038/ncomms1429), Pedro Costa from the University of Aveiro and colleagues from the National Institute for Materials Science, Japan, described how it was possible to directly image the dynamics