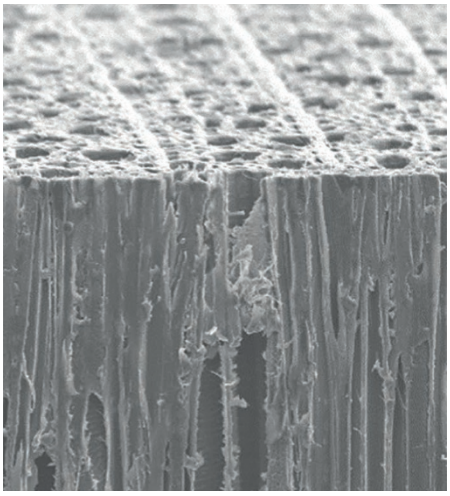
research highlights

BUILDING MATERIALS

Transparent wood

Adv. Energy Mater. 1601122 (2016)



WILEY

As a building material, glass is inefficient in terms of energy management and poses safety risks as it can easily shatter. Materials with greater thermal insulation and better light management than glass would significantly contribute to increasing the energy efficiency of buildings, considering that over 50% of the energy used in buildings is used for lighting and air conditioning. Liangbing Hu and colleagues at the University of Maryland, College Park, US, have now shown that wood can be processed into a transparent composite with superior optical and mechanical properties to glass, making it a promising candidate for use as a building material.

A wood composite with a transparency of 85% of the visible range is obtained by removing the lignin from the wood cells, which are then filled with a polymer that has the same refractive index as cellulose and hemicellulose — the compounds making up the cell walls. The cell walls, naturally vertically aligned, act as a waveguide for the light which is transmitted through the wood panel and scattered with a haze greater than 95%, resulting in uniform indoor lighting insensitive to the Sun direction. The composite has a thermal conductivity three times lower than that of glass, helping to maintain a constant temperature, and is much more ductile than glass, and thus better able to absorb impact energy. *ED*

LITHIUM–OXYGEN BATTERIES

Pre-lithiating silicon

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Lithium–oxygen batteries can potentially provide much higher energy densities than state-of-the-art battery technologies. However, the use of pure lithium metal as the anode is problematic as undesired electrolyte decomposition often takes place at the anode surface — especially when gaseous oxygen is present — which severely reduces the battery cycling stability. Besides, lithium deposition from the electrolyte can lead to dendrite formation on the lithium metal, which poses a short-circuit hazard. Silicon, on the other hand, offers an attractive anode candidate because of its high storage capacity and dendrite-free properties, but it suffers from its own problems such as huge volume expansion during charge and discharge, which also diminishes the cycling performance. Now, Haoshen Zhou and colleagues in Japan and China demonstrate how a lithium–oxygen battery with a silicon anode can achieve long-term operation.

Starting with commercial silicon particles, the researchers lithiated the material in a carefully designed lithium-ion half-cell, in which the silicon and lithium metal served as cathode and anode respectively and a lithium bis(trifluoromethylsulfonyl)imide salt with a tetraglyme solvent and a fluoroethylene carbonate additive was used as the electrolyte. The lithium–oxygen battery was then assembled with the pre-lithiated silicon as the anode. Because of the formation of a robust solid electrolyte interphase film on the silicon surface, both the volume change of the anode and undesired side reactions were effectively suppressed during battery cycling. *CZ*

HYDROGEN STORAGE

Cold feat

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Improving on-board hydrogen storage technologies is one of the main challenges associated with the continued development of fuel cell vehicles. Although present technology uses compressed hydrogen gas (CHG) at 700 bar and ambient temperature, using porous materials to cryo-adsorb hydrogen at lower pressures is being explored. Metal-organic frameworks (MOFs) are promising candidates, but materials with higher volumetric and gravimetric capacity would be preferable. Now, Taner Yildirim, Omar Farha, Jian Zhang, Randall Snurr and colleagues across the US predict that deliverable hydrogen capacities of 57 g L^{-1} for MOFs should be possible using cryogenic operating conditions, surpassing the value of 37 g L^{-1} realized in current technology.

The researchers first computationally construct a set of over 13,000 MOFs comprising a range of known and new structures, and then calculate the deliverable hydrogen capacity using molecular simulations, assuming hydrogen is adsorbed at 100 bar, 77 K and desorbed at 5 bar, 160 K. At these operating conditions, they find that many MOFs are superior to CHG at 700 bar. Guided by these results, they synthesize a subset of structures, including a new family of MOFs based on an unusual topology. Out of these, a previously prepared MOF (NU-1103) exhibits a volumetric capacity of 43 g L^{-1}, combined with promising stability and gravimetric capacity. *JG*

ELECTRICITY DEMAND

Consumption in the Persian Gulf

Energy Econ. **59,** 149–158 (2016)

Residential energy demand per capita in the six countries belonging to the Gulf Cooperation Council (GCC) — Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates — is significantly greater than in the OECD (Organisation for Economic Co-operation and Development) economies and China, and greater than the world average. Several factors might contribute to this remarkable situation, including the specific weather in the region, the fact that the administered nominal price for electricity is set at a level far below market price, and the domestic energy policies. Tarek Atalla from KAPSARC, Saudi Arabia and Lester Hunt from the University of Surrey, UK studied residential electricity consumption in the GCC and found that the estimated long-run price elasticity (a measure of the relationship between change in demand and change in price) for electricity is particularly low in the countries considered, ranging from −0.16 to 0.

Using an underlying energy demand trend approach that allows for the estimation of exogenous stochastic trends, the researchers find that each country shows specific consumption patterns, although some commonalities can be identified. In particular, the study underlines that simply increasing the electricity price is unlikely to reduce electricity consumption, given the existing low elasticity. These results suggest that effective energy policy to decrease energy consumption should aim to increase the price elasticity of electricity demand, for instance by prioritizing behavioural changes, and improve the energy efficiency of home appliances. *AR*

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