TRANSFORMING THE MATERIAL WORLD

XMU scientists are developing a series of fundamental and practical innovations which bring impressive engineering feats.

Materials scientists and civil engineers at XMU's College of Materials (CoM) and School of Architecture and Civil Engineering (SACE) are committed to creating a safer and greener world. Pushing the limits of traditional and new energy materials, and ensuring structural safety of infrastructures, they have turned challenges into opportunities for engineering feats.

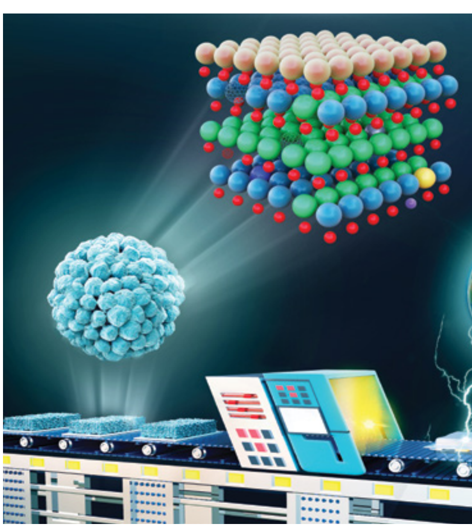
Improving material fabrication

Consolidated from multiple departments in 2007, CoM has since transformed many of its findings into industrial applications.

Dongliang Peng, its current dean, has been leading a team to improve the energy density and safety of lithium ion batteries, a central pursuit for the rise of electric vehicles. Peng's team focuses on high-capacity Li-rich layered oxides (LLO), which are considered a promising cathode candidate. In conquering the inherent limitations of LLO cathodes, they have devised effective strategies based on defect engineering to enhance the initial Coulombic efficiency, promote the rate capability, and suppress the capacity degradation and voltage decay. Their simple and low-cost approach to improve the comprehensive electrochemical performance of LLO cathodes has enabled large-scale synthesis (>2.0 kg) of LLO cathode materials in a single run, paving the way for LLO-based advanced lithium-ion batteries.

Peng's CoM colleague, Lifu Chen, leads a team to improve technologies for preparing continuous ceramic fibres, which, combining high strength with elasticity, and resistant to heat and corrosion, are popular structural materials in high-temperature applications. Chen's fibre materials can maintain stability at ultra-high temperatures of 1,600°C. Such tolerance makes ideal fibre-reinforced ceramic composites for heat exchangers, high-temperature gas filtration and gas engines. Chen's team has also prepared wave-transparent fibres with good heat tolerance and very low dielectric loss, promising for antenna window materials. Their wave-absorbing fibres are good candidates in electromagnetic wave shielding applications.

Using breath figure (BF), an efficient self-assembly method for forming porous polymer films, a CoM team led by Lei Li has fabricated polymer films with light-regulated patterns, carbon nanotubes, and microsieves. Their static BF process, in a closed space, cancels airflow and humidity disturbance. This improves reproducibility, allowing for low-cost, large-scale production of ordered porous films.



LLO cathodes with enhanced comprehensive electrochemical performance can be synthesized on a large scale.

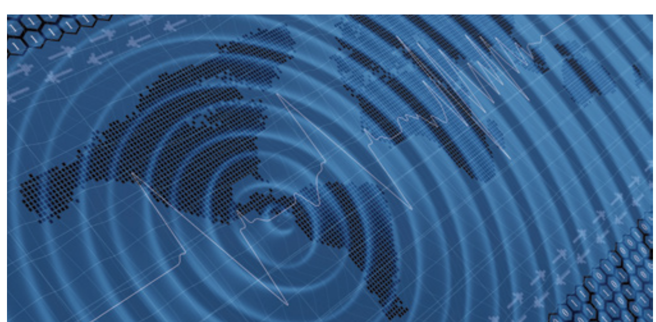
Optimizing health checks for structural safety

To monitor and mitigate structural damage caused by disasters, SACE's Ying Lei has led a team that integrates physics and information science to build intelligent identification and control systems. Based on data integration, new Kalman filter methods proposed by Lei's team have enabled simultaneous identification of structural systems and unknown inputs, substructural identification, decentralized structural control, synthesis of identification and vibration control, and identification of nonlinear characteristics of model-free dampers. Their diverse applications include displacement monitoring of long-span bridges and multi-scale structural damage analyses.

Applications of their research are also demonstrated in a corrosion sensor based on fibre grating, used in the Xiang'an subsea tunnel, and studies of typhoon properties based on observation data from Xiamen, informing wind-resistant structural design.

Based upon computer simulation, SACE's Dongdong Wang specializes in developing robust numerical methods to analyse structural failure caused by disasters.

Focusing on mesh-free methods in computational mechanics, which are ideal for modelling large deformation structural failure, Wang's team has improved computational efficiency and accuracy, balancing the needs for large-scale computation and fine-scale simulation in the analysis of complex engineering structures. Their numerical approaches are capable of accurately estimating multi-scale structural damage and failure caused by disasters. ■



Improved computational efficiency and modelling enable precise estimates of structural damage caused by earthquakes.

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