Battling pollution with better materials

A research team is developing carbon-based materials to reduce pollution and emissions.

Shanghai University has developed a novel industrial membrane, which is being used to treat and recycle 15.7 million tonnes of industrial concentrated brine in a petrochemical plant in China, each year, reducing discharge of highly saline organic wastewater.

Organic wastewater has a salt content of at least 1%, and mainly originates from chemical plants and the petrochemical sector, whose output contains oil, organic heavy metals and radioactive substances. To separate the pollutants, Minghong Wu, a professor at SHU's School of Environmental and Chemical Engineering, and a member of the Chinese Academy of Engineering, has developed a graphene oxide industrial membrane which can prevent the passage of a particular component, while maintaining a high flow of water. The membrane is being used at the Inner Mongolia Yitai Petrochemical company.

"By inserting hydrated metal ions between graphene oxide layers, we achieved precise control of the interlayer spacing of graphene materials, improving their screening performance and accuracy. Using this membrane, salts and organic matters can be fully separated. This creates a new approach of water treatment that combines water purification and material resource use," Wu says.

According to her, "conventional environmental management tools often target pollution reduction or carbon reduction, but don't combine both effectively." It's even more difficult to find an efficient solution for multi-medium pollutants, which pose a threat to the atmosphere, water, soil, organisms and humans.

By studying the composition of mixed pollutants, Wu has made significant contributions to environmental functional materials research and combined pollution control engineering. Her team has developed many carbon-based functional materials which can help prevent pollution, while saving energy.

Another material developed by the team is a composite absorbent based on graphene — a thin and strong nanomaterial with excellent electrical and thermal conductivity. This absorbent has been used to treat Volatile Organic Compounds (VOC), chemical compounds that evaporate easily at room temperature, which are important precursors for the formation of ozone (O_3) and fine particulate matter (PM2.5) pollution.

Wu's team has taken on all VOC treatment projects for Jiangnan Shipyard, in Shanghai, one of China's main shipbuilders. The treated non-methane total hydrocarbons, an atmospheric pollutant, are below a fifth of the permitted concentration of China's national standard. The concentration of benzene series is lower than the detection limit (<0.02 mg/m³) of gas chromatography, an analytical technique that separates the chemical components of a sample mixture, then detects their presence or absence.

Wu is committed to advancing research on environmental functional materials to help China achieve its carbon goals. "We will continue to tailor high-performance solutions to cut pollution and reduce emissions from industry," says Wu. ■

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