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Ultra-thin membrane made by Atomic layer deposition for CO_2 separation

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The global organic biogas market was worth more than $19.5 billion (€17.2bn) in 2015 and is forecast to exceed $32 billion by 2023, growing at more than 6% CAGR from 2016 to 2023. Biogas is primarily methane (CH4) and carbon dioxide (CO_2). Separation of CO_2 from CH4 is an importance step for biogas upgrading. Conventional approach uses pressure swing adsorption (PSA) to remove CO_2 from biogas, which is energy intensive. Membrane separation is in general more energy efficient, but the low CO_2 permeability of current CO_2 membrane results in a consequence that the CO_2 separation process typically requires compressing gas to a high pressure to achieve high separation flux, which also consumes a large amount of energy. Therefore a highly permeable and highly selective CO_2 membrane is critical for cost-effective biogas purification. Reduced membrane thickness and precise pore size/chemistry control are the keys for achieving combined high flux and selectivity. Membranes in natural biological systems can be down to 4 nm in thickness and the pores are precisely constructed by molecular assembly, leading to unbeatable performance when compared to synthetic industrial membranes that are difficult to be fabricated with similar molecular level precision and are typically 100-1000 times thicker. ALD is a layer-by-layer deposition method that builds up a thin layer with atomic precision in structure and compositions. Here we introduce the membrane fabrication by the combination of molecule self- assembly and a "plasma-defined" ALD process where the location of ALD modification is confined by plasma irradiation. Using this approach, hierarchically structured sub-20nm thick ultra-thin membranes with precisely defined pore size and pore surface chemistry have been successfully formed, leading to excellent CO_2 permeability and selectivity.

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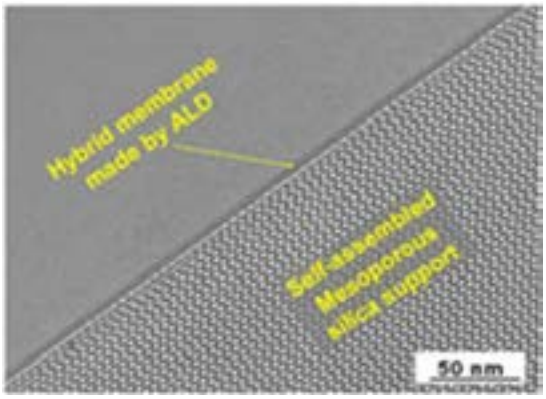

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Biography

Ying-Bing Jiang has his expertise in thin film materials and selectively permeable membranes. He developed the method of using plasma-defined atomic layer deposition (ALD) to make sub-10nm ultra-thin membranes. He is a research Professor at the University of New Mexico as well as the founder of Angstrom Thin Film Technologies LLC, USA. In recent years his researches focus on tuning nanostructures by ALD and plasma-ALD, and their applications in ultra-thin membranes for gas separation and selective ion transport. In 2011, one of his ultra- thin desalination membranes received the prestigious "R&D 100 Award" from R&D Magazine. In 2015, his liquideous CO_2 separation membranes received another "R&D 100 Award" that was entitled "Green Technology Special Recognition Gold Award ". Dr. Jiang has also been served as the symposium organizer/session chair and delivered invited talks for a number of major international conferences such as MRS meeting, ACS conferences etc.

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