Simple and Low-Cost Approach to Fabricating Anti-Fouling Membranes

Patent Title:	Doping of Inorganic Minerals To Hydrophobic Membrane Surface
US Regular Application No:	13/217,837
PCT Application No.:	PCT/CN2011/001490
Versitech Ref No:	IP00366

This invention enables membrane manufacturers to fabricate fouling-resistant ultrafiltration/microfiltration membranes in a simple and low-cost way with only a minimal change to their existing production method.

Market Opportunity

The estimated world membrane market was US$12.4 billion in 2008, according to Frost & Sullivan, of which microfiltration (MF) and ultrafiltration (UF) membranes accounted for nearly 50%. The membrane market is expected to grow at a compound annual growth rate (CAGR) of 9.0% from 2008 to 2015. The high growth rate and market share of membrane systems technology are because of its high selectivity, high reliability and low expertise requirement during application.

The fastest-growing membrane market is the application of UF/MF membranes in water recycling. UF/MF is able to treat wastewater to tertiary level and produce high quality treated water which can be used for indirect potable uses. It is the most sought after technology by both municipal and industrial end users. With more stringent regulations for treated water and the growing scarcity of clean fresh water, this market is sure to continue to grow in future years. Surface hydrophilication of UF/MF membranes is a routine practice during their production, which greatly increases the fabrication cost. Facile and cheap approaches of surface modification are desired and could help to boost the membrane market.

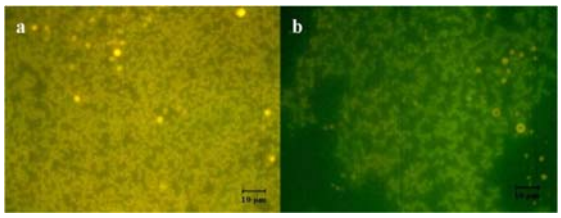
The HKU Invention

There are a number of practical approaches for the surface hydrophilication of UF/MF membranes, through which a hydrophilic layer is coated or formed in situ on the top. Most of those approaches involve a post-treatment step after the “raw” membrane is produced, which greatly increases the membrane production cost [1]. Moreover, the coated materials tend to detach because of the lack of adhesion forces. The development of a one-step approach is attracting a lot of research interest, which focuses on blending hydrophilic inorganic materials [2] or amphiphilic polymers [3] into the cast solution. Apparently, most of the blended materials are wasted because only very limited materials are located in the membrane surface region. In any case, both hydrophilic or amphiphilic polymers are vulnerable to hydrolysis and/or chemical attack, such as during membrane cleaning that uses acids and oxidants.

This invention describes a new one-step approach, which involves the in-situ embedment of inorganic nanoparticles onto the membrane surfaces. Most of the particles are tightly anchored in the membrane matrix and as such are resistant to hydraulic shear forces. Moreover, the inorganic particles are chemically inert and will survive even after a long-lasting harsh chemical attack. Therefore, the membrane production cost will be greatly reduced while the membrane life can be prolonged.

An optional post-step is to further grow the embedded nanoparticles, by which the coverage ratio of inorganic

materials on the membrane can be increased. A higher coverage ratio means a higher membrane surface hydrophilicity and as such a higher anti-fouling capacity. Moreover, by this step the mineral forms of the particles may also be changed for specific application requirements.



The tendency of *E. coli* attachment on the surface of a standard membrane and this new invention, were compared by fluorescent microscopic observation after staining. It was found that the standard membrane observed in Fig(a) was unavoidably covered by a considerable amount of *E. coli* bacteria after the cultivation period. However, after the embedment of inorganic nanoparticles onto the membrane surface, the coverage of *E. coli* bacteria on the membrane surface was significantly reduced as observed in Fig(b).

About the Lead Inventor

The lead inventor of this approach is Dr Kaimin SHIH, who is currently an Assistant Professor in Environmental Engineering at the University of Hong Kong. Dr Shih's main research interest is in engineering and employing material properties for innovative environmental applications, particularly for waste and water technologies such as the reuse of waste materials for green products, the fabrication of catalysts/membranes for water treatments, and the recovery of nutrients from wastewater. He received his M.S. (99-00), Ph.D. (00-05) and postdoctoral (05-07) trainings in Environmental Engineering & Science from Stanford University (USA). Dr Shih currently also serves as an Executive Committee Member of Hong Kong Waste Management Association, the Director of the Overseas Chinese Environmental Engineers and Scientists Association, and the Associate Editor of The HKIE Transactions.

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