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Continuous, selective and simultaneous oil/water separation with functionalized meshes by atmospheric-pressure cold plasma

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From past to future, oil-water separation is one of the biggest issues. Not only oil spills but also industrial waste water, its threatening drives us to serious environmental problems. For example, oil spill disasters in Taean of Korea (2007) and Gulf of Mexico (2010) show the importance of the development of efficient oil-water separation methods for clean-up [1]. In addition, the oil-water separation methods are also demanded in other domains generating oily waste waters such as food industry or factories using cutting fluids. To solve the potential problems, many kinds of oil-water separating techniques have been suggested. In general, the commonly used methods such as gravity separation, filtration, centrifugation, flotation or electrochemical methods, many alternative ways are being investigated for decades [2-4]. However, most of them have problems to overcome. For example, batch processes, time consuming steps, generating secondary pollutions are many hurdles to achieve high efficiency, low cost, continuous operation and bulk processing to widely used in industries [5].

In this work, therefore, we suggest a continuous and selective oil -water separating method with antagonistically functionalized meshes. The surfaces of were selectively functionalized into hydrophobic/oleophilic or hydrophilic/oleophobic property by atmospheric-pressure cold plasma treatment in open air as seen in Fig.1a. Through the simple tuning of the plasma chemistry, a 10-minute plasma treatment enabled the fabrication of oil-water separating mesh membranes having superhydrophobic/superoleophilic or superhydrophilic/underwater-superoleophobic properties, respectively. The physical and chemical analyses of the membranes via SEM and XPS clearly highlighted the importance of the synergetic effects between surface chemistry and morphology to obtain different surfaces' wettabilities. The plasma modified mesh membranes continuously separated oil and water over 12 hours and also showed high separation flow rates of water (400,000 L m^{-2} h^{-1}) and oil (3,830 L m^{-2} h^{-1}) in a lab-made separating system illustrated in Fig.1b. The purity of separated oil or water was very high (> 99.9% v/v) was confirmed through distillation method and FTIR analysis as shown in Fig. 2. This fast, low-cost and continuous plasma-based process is easily up-scalable and can be readily and widely adopted for the mass production of selective functionalized membranes for oil-spill pollution control or water purification in industries

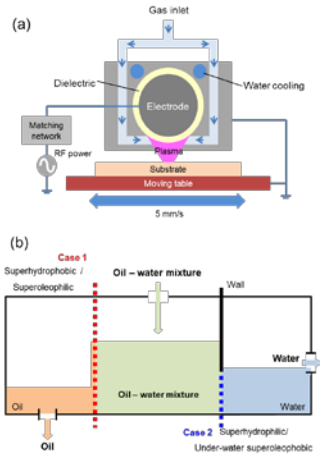

Fig.1 (a) experimental setup and (b) separating system

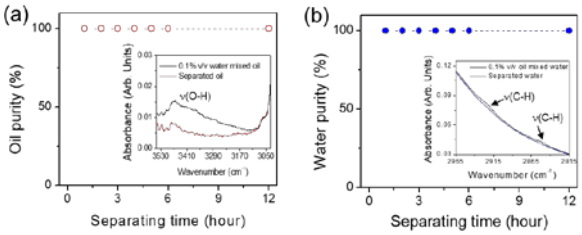

Fig.2 Purities of separated oil and (b) water by distillation and FTIR (inserted figure)

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