Unleashing Molecular Intelligence: pH-Regulated MoS_2 Membranes for Autonomous Wound Infection Monitoring

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Intelligent movement of molecular moieties through biological membranes is critical for numerous biological processes [1]. By utilising pH responsive MoS_2 laminates, we describe an advancement in the construction of programmable membranes. Present study shows that 1T' MoS_2 composite membranes are permeable to water, whereas 2H MoS_2 composite membranes are not. The interaction of charge/ions within the interlayers of 1T' MoS_2 membranes facilitates water adsorption via cation hydration, which is related to the water penetration behaviour [2]. In contrast, the shortage of charge across the multiple layers of 2H MoS2 explains its impermeability to water molecules. We obtain exceptional flipping of water permeation by manipulating the charge in 1T' MoS_2 layers by pH modulation. Sulphur atoms undergo reversible hydrogenation at acidic pH, resulting in the elimination of charges from the different layers and cations from the between-layer spaces, making the membranes impervious. At basic pH, however, both the adsorbed cation level and water permeability returns. This pH-dependent hysteresis in water and ion permeation arises from the minimal amount of H^+, which required for protonation and the minimum availability of OH^- are necessary to break S–H bonds [3,4]. Additionally, we discover that quick water transport through MoS_2 membranes is unaffected by the nature of the MoS_2 layer and is predominantly controlled by a hydrogen-bonded network of constrained water and relatively weak water- MoS_2 couplings. MoS_2 laminates pH-responsive behaviour has potential implications for wound infection surveillance [5]. The pH mediated water permeation can act as a signal of infection presence or absence by inserting these adaptive membranes into wound dressings or sensors. This breakthrough provides the possibility for unsupervised wound-related infection tracking, allowing for early diagnosis and intervention. Further research and development will be required to capitalise on the possible uses of these hysteresis-based membranes, which range from filtration to biological processes mimicking.

References

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