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A REVIEW: NANO MEMBRANE AND APPLICATION

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Abstract: The Nano Membrane very important role paly in various fields of Research and Industrial levels and its application such as Cylindrical, Conical and Pyramidal shape pores can be formation to several types of Materials. Surface modification of Nano pore size surfaces can give unique mass properties and characteristics that have recently been explored for Polymers, Fibers and Biomolecules separation, detection and purification. In this review to focus on the use of Nano Membranes for mass transfer Diodes that act analogous to solid state devices based on electron conduction. Asymmetric pores such as conical pores superior performance compare to cylindrical pores in ion rectification to be exploited in Nano Polymers to separation of Biomolecule, Bio- Sensing, Microfluidics, Logic-gates, and Energy harvesting and storage...etc.

Keywords: - Nano Membrane, Biomolecule, Polymers, Fibers, Energy….etc.

I. INTRODUCTION

Nano membranes may be defined as synthetic structures with a thickness below 100 nm and surface area to volume ratio increase aspect of at least a few orders of magnitude. Being quasi-2D, they exhibit a host of unusual properties useful for various applications in energy harvesting, sensing, optics, plasmonics, biomedicine, *etc.* nanoparticle fillers into the Nano membrane scaffold, Nano membrane surface sculpting and modification through patterning, including formation of Nano hole arrays and introduction of ion channels similar in function to those in biological Nano membranes [25] Such dimensions make them a hybrid between micro and Nano systems, even Nano systems, since their lateral dimensions the thickness remains Nano metric. Molecular designed at the nanometer-scale using membranes like as polymers offers great potential for high selectivity and high fluxes. Many applications, in various field of research, industrial, pharmaceutical, medicals and biological approaches including protein separation and purification, biomolecule detection and drug delivery, are now being realized with Nano scale pore structures that can give high molecular characteristics [1–3]. The factor is enhanced molecule pore interaction sin Nano pores. It is important to understand the effects of pore size and shape pore surface modification, and possible osmotic flow and electric field variability within Nano pores. Taken together, these parameters control the flux of bio-macromolecules through Nano pores. In the few years ago, Nano porous membranes with a reasonably uniform pore-sized is attribution have become commercially available. Membranes with nanometer-scale features have many applications, such as in optics [4], electronics [5], catalysis [6], selective molecule separation [7–9], filtration and purification [10], bio sensing [11–13], and single-molecule detection [14–16]. Physical filtration and molecular separation by Nano membrane, and Nano molecule inter actions were described by experiments and theory after

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the development membranes [17]. The evolution of Nano technology has provided new opportunities for using smaller and more regular structures for porous membranes. Artificial sieves with higher precision and greater flexibility than track etched membranes have been produced, with commensurate at improvements in performance and functionality [17]. These new filters have facilitated the most detailed scientific investigations to date of membrane-performance-related phenomena .In addition, meso porous materials, such as meso porous nanoparticles, are useful for species detection, and for uptake and controlled release of biomolecules [18]. In this review we examine important developments in Nano membranes to improve transport and selectivity, with a focus on protein transport .Specifically; we discuss Nano pore surface modification, control transport in Nano membranes via external methods, protein separation, protein fouling, ion rectification and recent theoretical modeling of transport in Nano membranes.

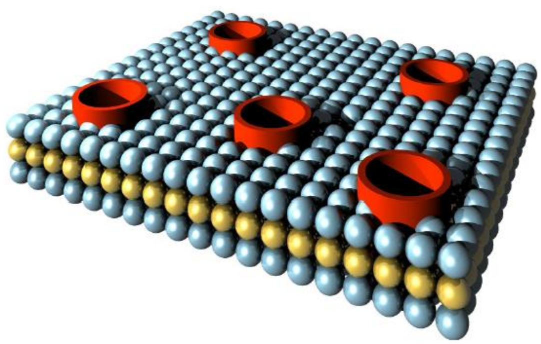

Figure1. Artificial ion channels (red cylinders) built into a three-layer nanomembrane.(Zoran Jaksic 2011)

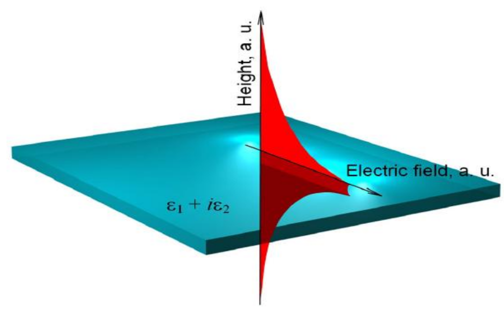

Figure2. Long-range surface-plasmon-polariton (SPP) propagation on a self-supported nanomembrane. "1; "2: Dielectric functions. a.u.: Arbitrary units.(Zoran Jaksic 2011)

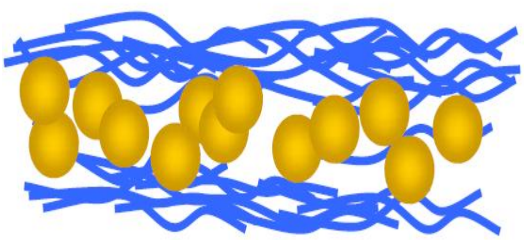

Figure 3. Nano membrane, yellow nanoparticles and blue Nano polymers(Kenichi Takahata, 2009)

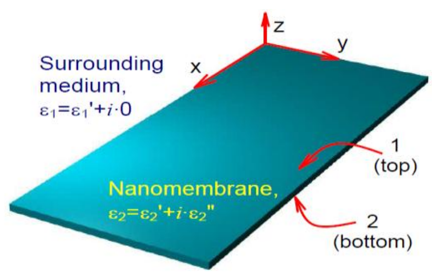

Figure 4. Basic configuration of a freestanding nanomembrane guide for long-range surface plasmon polariton propagation (metal-dielectric interface) (Kenichi Takahata, 2009)

II. NANO MEMBRANE MATERIALS [19-22]

1. *Nano Polymer Membranes like materials such as examples:* Cellulose Acetate, Cellulose Nitrate, Polyacrylonitrile, Polyvinylchloride, PVC copolymer, Aromatic polyamide, Aliphatic polyamide, Polysulfone, Polycarbonate, Polypropylene, Polytetrafluoroethylene, Polyvinyledendifluoride, Polydimethylsiloxane etc.
2. *Inroganic substrate contained nano Membranes:* materials are Oxides contained like as alumina, titanium, zirconium,and silicium and silicium carbide, metals based iron palladium,and zeolites, carbons etc.

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3. *Nanofunctionalized Membranes* based polymer membrane like as polysulfone, doped with Ag NP, resistant to bio-chemicofouling.

III. NANO MEMBRANE FILTRATION PROCESS

Filtration is a process of removing particulate matter from water by forcing the water through a porous media. This porous media can be natural, in the case of sand, gravel and clay, or it can be a membrane wall made of various materials. Sometimes, large particles are settled before filtration; this is called sedimentation. [30-32]

1. *Microfiltration (MF):* Microfiltration is a low pressure means of separating large molecular weight suspended or colloidal compounds from dissolved solids. Applications include cell harvesting from fermentation broths, fractionation of milk proteins, corn syrup clarification and CIP chemical recovery. Microfiltration removes particles in the range of approximately 0.1 to 1 micron. In general, suspended particles and large colloids are rejected while macromolecules and dissolved solids pass through the MF membrane. Applications include removal of bacteria, flocculated materials, TSS (total suspended solids). Transmembrane pressures are typically 10 psi (0.7 bar).[34]

2. *Ultrafiltration (UF):* Ultrafiltration is a selective separation step used to both concentrate and purify medium to high molecular weight components such as plant and dairy proteins, carbohydrates and enzymes. Common areas of application are whey protein concentration, gelatin de-ashing and concentration, and clarification of fruit juices. Ultrafiltration provides macro-molecular separation for particles in the 20 to 1,000 Angstrom range (up to 0.1 micron). All dissolved salts and smaller molecules pass through the membrane. Items rejected by the membrane include colloids, proteins, microbiological contaminants, and large organic molecules. Most UF membranes have molecular weight cut-off values between 1,000 and 100,000. Transmembrane pressures are typically 15 to 100 psi (1 to 7 bar).[34]

3. *Nanofiltration (NF):* Nanofiltration is a unique filtration process in-between UF and RO designed to achieve highly specific separations of low molecular weight compounds such as sugars from dissolved minerals and salts. Typical applications include de-ashing of dairy products, recovery of hydrolyzed proteins, concentration of sugars and purification of soluble dyes and pigments. Nanofiltration refers to a speciality membrane process which rejects particles in the approximate size range of 1 nanometer (10 Angstroms), hence the term "nanofiltration.". Organic molecules with molecular weights greater than 200-400 are rejected. Also, dissolved salts are rejected in the range of 20- 98%. Salts which have monovalent anions (e.g. sodium chloride or calcium chloride) have rejections of 20-80%, whereas salts with divalent anions have higher rejections of 90-98%. Typical applications include removal of color and total organic carbon (TOC) from surface water, removal of hardness or radium from well water, overall reduction of total dissolved solids (TDS), and the separation of organic from inorganic matter in specialty food and wastewater applications. Transmembrane pressures are typically 50 to 225 psi (3.5 to 16 bar).[34]

4. *Reverse Osmosis (RO):* Reverse Osmosis is a high pressure, energy-efficient means of de-watering process streams, concentration of low molecular weight compounds or clean-up of waste effluents. Common applications include pre-concentration of dairy or food streams prior to evaporation, polishing of evaporator condensate, and purification of process water. The RO membrane acts as a barrier to all dissolved salts and inorganic molecules, as well as organic molecules with a molecular weight greater than approximately 100. Water molecules, on the other hand, pass freely through the membrane creating a purified product stream. Rejection of dissolved salts is typically 95% to greater than 99% Also, RO is often used in the production of ultrapure water for use in the semiconductor industry, power industry (boiler feed water), and medical/laboratory applications. Utilizing RO prior to ion exchange dramatically reduces

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operating costs and regeneration frequency of the IX system. Trans membrane pressures for RO typically range from 75 psig (5 bar) for brackish water to greater than 1,200 psig (84 bar) for seawater.[34]

Materials used for formation of Nano Membranes	Applications			
	Micro Filtration	Ultra Filtration	Nano Filtration	Reverse Osmosis
Cellulose Acetate	Y	Y	Y	Y
Cellulose Nitrate	Y	N	N	N
Polyacrylonitrile	N	Y	N	N
Polyvinylchloride	Y	N	N	N
PVC copolymer	Y	Y	N	N
Aromatic polyamide	Y	Y	Y	Y
Aliphatic polyamide	Y	Y	N	N
Polysulfone	Y	Y	N	N
Polycarbonate	Y	N	N	N
Polypropylene	Y	N	N	N
Polytetrafluoroethylene	Y	Y	N	N
Polyvinyledendifluoride	Y	Y	N	N
Polydimethylsiloxane	Y	Y	N	N

Table 1.Nano Materials and application [33]

IV. NANO MEMBRANE PROPERTIES

1. Membrane is an absolute barrier
2. Membrane types and process can be chosen according the treatment requirments
3. Disinfection can be performed without chemicals
4. Less space than conventional treatment schemes
5. Modular Design
6. Energy requirement low
7. Fluxes

V. NANO MEMBRANE LIMITATIONS

1. *Membrane fouling:* they may be depending on feed composition, optimization and operational cleaning.
2. *Membrane stability:* they may be depends on material like as chemical resistance against cleaning agents.

VI. NANO MEMBRANE LAMINATION

The Nano membranes are to fabricate sandwich structures to deposit ultrathin layers with different properties. The properties of each layer itself are not modified and the Nano compositing is obtained only through the combination of new planes. The newly added strata are still quasi-2D; their thickness is orders of magnitude smaller than their width and length and is in nanometer range. The bottom limit to the thickness of a specific stratum is determined as that of a single

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monatomic/monomolecular layer. The obtained sandwich superstructures are variably denoted as layered, laminar or stratified. The layered Nano membranes are a special case of laminar Nano composites. The layered Nano membranes may consist of two strata (the simplest case) or more. Each stratum introduces its own properties and functionalities to the Nano composite to contribute to its multi functionality. For instance, one stratum may have a biological or chemical activity, a ligand layer to attract selectively only a specific species; another may be a plasmonic waveguide and ensure the possibility for biological sensing; the next layer may be introduced to ensure mechanical strength and robustness of the whole structure.

1. *Microfabrication:* The basic way to fabricate laminar Nano membranes is micro fabrication. Practically all of the methods for thin film deposition are available to this purpose, the limits being set by the sensitivity of the particular materials to the operating conditions of the necessary technological cycles. Maybe the most often used technique is sputtering deposition of the desired material combination. Also available are vacuum evaporation and various kinds of chemical vapor deposition (CVD) or physical vapor deposition (PVD). Epitaxial growth from vapor or liquid phase ensures fabrication of single crystalline layers, and among the applicable methods the molecular beam epitaxy surely stands out. Other methods are available for more sensitive nanomembranes, for instance the organic ones, although of course these methods can be applied for the more enduring ones as well. One of the approaches to use spin coating [26], which utilizes the standard spinners for resist deposition, but the composition of the solution is determined by the desired material and required final thickness. Another convenient approach for sensitive multilayers is to use electrochemical deposition. Other conventional microfabrication techniques for such materials include dip coating, chemical deposition and others

2. *Langmuir-Blodget Technique:* The Langmuir-Blodget (LB) technique is the fabrication of lamellar nanofilms using amphiphilic molecules/surfactants like fatty acids, phospholipids, and glycolypids. When such molecules are placed at an air/water interface a monomolecular film is formed since the amphiphilic molecules orient themselves in such a manner to minimize free energy and thus form an insoluble monolayer. This monolayer can be transferred to a solid substrate utilizing its vertical movement into immersion, dipping from the interface between the Langmuir monolayer and water (Figure 5). The whole procedure is repeated until the desired lamellar multilayer is formed. The LB technique is a biomimetic self-assembly procedure, miming the forming of cell membranes and applying the process for the formation of multilayers. Various types of substrates may be used, either hydrophobic or hydrophilic. [27,28]

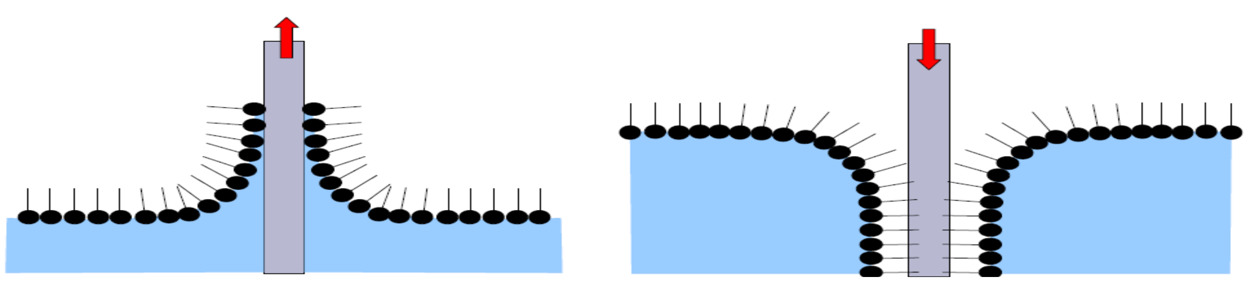

Figure 5. Schematic presentation of Langmuir-Blodget Technique for hydrophilic and hydrophobic substrates.(Zoran Jaksic 2010)

3. *Layer-by-Layer Technique:* The Layer-by-Layer (LbL) technique is a self-assembly method that utilizes the alternate adsorption of oppositely charged macromolecules. It proceeds as follows (Figure 6) the sacrificial substrate, for

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instance silicon diaphragm, is immersed into a dilute solution of a cationic polyelectrolyte. The polyelectrolyte adsorbs as a single monomolecular sheet with a thickness of about 1 nm, which depends on the particular material used, after which the wafer is rinsed and dried. In the next step, the polycation-covered substrate is placed into a dilute dispersion of polyanions nanoparticles. A new monolayer is formed over the previously deposited one, and the wafer is again rinsed and dried. In this way a single cycle is finished of the self-assembly of a polyelectrolyte monolayer onto the substrate. [29]

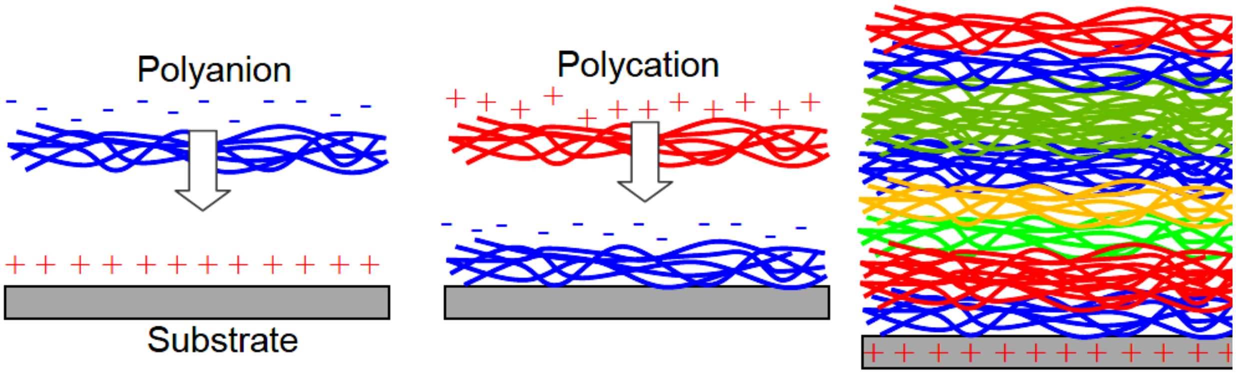

Figure 6. Layer-by-layer nanomembrane assembly technique. Left: assembly of the first layer; middle: assembly of the second layer; right: final structure (.Zoran Jaksic 2010)

VII. APPLICATION OF NANO MEMBRANE

1. *Wastewater treatments:* However, the presence of contaminants such as natural organic matter (NOMs) and trace organics accumulating in raw water creates a major problem. The coagulation/flocculation and chlorination technology has been widely used for the removal of the contaminants. However, this technology is unable to completely removal it, and generates extra volumes of sludge which requires further treatment and disposal. In addition, aluminium exposure is suspected to play a part in the onset of Alzheimer's disease. Nanotechnology has great potential in molecular separation applications by offering more precise structural controlled materials for such needs. Titanium oxide (TiO2) nanosized particles are a popular photocatalyst which attract much attention from both fundamental research and through the practical application of removing HA from water. The robust and free-standing TiO2 nanofibre membrane as in the form of a "spider web" nonwoven. The nontoxic TiO2nanofibre membrane acts as both filtration membrane and photocatalyst in water technologies. In the presence of ultraviolet light, the crystalline TiO2 nanofibre is known to produce strong oxidant and exhibit quantum size effects at nanosize (<10 nm). This material also can be used in solar conditions. These unique properties give rise to various applications particularly in producing cost effective commercial filtration membranes that could dramatically reduce the cost of water production.[35]

2. *Chemical industry:* the manufacturing process and microscopic structure of nanoporous ceramic membranes, mainly focusing on zeolite materials,as well as the energy-saving effect of membrane separation expected in various chemical synthesis processes. It is expected that more and more separation membrane technologies that can fulfill the needs of various chemical synthesis processes are developed, and a significant reduction in environmental load in the chemical synthesis industry is also achieved.[36]

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3. *Food industry:* Membrane technologies have many advantages over other separation approaches in food processing. Recently nano-filtration technology, which is a new category of membrane technology placed between reverse osmosis and ultrafiltration, has been attracting a great deal of interesting characteristics of membrane technology including nano-filtration are presented, and applications in the food industry.[37]

4. *Biotechnology and Medical Application:* today various form application present in Nano science such where descript on Nanoporous anodic aluminium oxide (AAO) has become increasingly important due to its biocompatibility, increased surface area and the possibility to tailor this nanomaterial with a wide range of surface modifications. which results in the self-assembly of highly ordered, vertical nanochannels with well-controllable pore diameters, depths and interpore distances, as nanostructured substrates for cell-interface studies on cell adhesion and proliferation on different geometries and surface modifications are future applications of nanoporous alumina membranes in biotechnology and medicine are also outlined, for instance the use of nanoporous as implant modifications, co-culture substrates or immunoisolation devices.[38,39]

VIII. CONCLUSIONS

Nanotechnology is established in membranes already for decades to Nano filtration, purification and sterilization are only one of the membrane classes Micro-filtration, ultrafiltration, Nano-filtration and reverse osmosis membrane contain nonporous. New developed Nano functionalized membranes like as carbon nanotube membranes and others chemicals substrate using in various fields of research and industries. Membranes are already widely applied for communal water treatment and health example's potable water, waste water, water recycling. Many industries do to use cleaning application including water and product recovery.

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