Casa abierta al tiempo
UNIVERSIDAD AUTÓNOMA METROPOLITANA

DR. JUAN MORALES CORONA
Jefe del Departamento de Física

CdMx a 10 de marzo de 2026.

DR. ROMAN LINARES ROMERO
Presidente del Consejo Divisional de
Ciencias Básicas en Ingeniería
PRESENTE.

Después de haber revisado el informe de actividades realizadas por el **Dr. Humberto Vázquez Torres**, durante su periodo sabático, me permito informarle a usted que, a mi juicio, los objetivos se cumplieron de forma satisfactoria.

De esta manera pongo a su consideración que se incluya en la orden del día de la próxima sesión del Consejo Divisional que usted preside la presentación del informe.

Sin más por el momento, quedo a sus órdenes para cualquier duda o aclaración al respecto.

[redacted]

ATENTAMENTE
"CASA ABIERTA AL TIEMPO"

Casa abierta al tiempo

UNIVERSIDAD AUTÓNOMA METROPOLITANA

CONSEJO DIVISIONAL DE CIENCIAS BÁSICAS E INGENIERIA

INFORME DE PERÍODO SABÁTICO

DATOS GENERALES

Nombre del profesor: Humberto Vázquez Torres Nº empleado[redacted]

Departamento: Física Área: Polímeros

Teléfono particul[redacted] Extensión UAM-I[redacted] E-ma[redacted]@xanum.uam.mx

DATOS DEL PERÍODO SABÁTICO SOLICITADO

Nº meses solicitados: 22 Fecha de inicio: 24/02/2024 Fecha de terminación: 25/12/2026

Institución donde se realizará:

Depto., Laboratorio, etc.: Departamento de Física, Laboratorio de Polímeros.

Domicilio de la institución: Av. Ferrocarril San Rafael Atlixco 186, Leyes de Reforma, Iztapalapa, 09310, CDMX.

Teléfono[redacted] Fax: E-ma[redacted]@xanum.uam.mx

OBJETIVOS DEL PERÍODO SABÁTICO

Desarrolar investigación sobre mezclas poliméricas, caracterizarlas y evaluar sus aplicaciones potenciales. Escribir los artículos derivados de dichas actividades de investigación y enviarlos a revistas indexadas. Colaborar más asiduamente con el cuerpo Académico de Biomateriales e Ingeniería de Tejidos del Área de Polímeros y con los grupos de investigación del CICY y del TESE.

METAS ALCANZADAS EN EL PERÍODO SABÁTICO

☐ Memorias in extenso en libro de resúmenes*

☑ Artículos de investigación en revista indexada*

☑ Presentaciones en congresos

☑ Libros o capítulos de libros

☐ Grado

☐ % Avance de estudios de posgrado

☑ Otros (especifique): Divulgación

* Indicar en anexo si se trata de trabajo publicado, aceptado o sometido

TIPO DE ACTIVIDADES ACADÉMICAS DESARROLLADAS
(Indique aquellas relacionadas con las actividades desarrolladas)

☑ Investigación ☑ Docencia ☑ Difusión
☐ Formación académica ☐ Formación profesional ☐ Entrenamiento técnico
☐ Otros (especifique): ______________________________

RESUMEN DEL PLAN DE ACTIVIDADES ACADÉMICAS DESARROLLADAS
(El llenado de esta sección no sustituye el informe detallado de actividades)

Se publicaron cuatro artículos de investigación en revistas indexadas y un capítulo de libro en la Editorial John Wiley en colaboración con investigadores del Cuerpo Académico del Área de Polímeros, del CICY y del TESE.
Se publicó un artículo de divulgación en la revista Contactos de la UAM - Iztapalapa sobre "Los polímeros en la medicina"..
Se presentaron dos trabajos en sendos Congresos de .Biomateriales y Medicina Regenerativa 2024 y 2025 (no se recibieron extensos).
No entrego notas de curso porque opté por darle formato de libro sobre Espectroscopía FTIR aplicacada mezclas poliméricas.

PARA USO DEL JEFE DE DEPARTAMENTO
Después de haber evaluado el informe detallado de actividades del período sabático del interesado según los lineamientos establecidos para tal efecto; informo al Consejo Divisional que:

☑ Los objetivos SE cumplieron satisfactoriamente
☐ Los objetivos SE cumplieron parcialmente
☐ Los objetivos NO se cumplieron
☐ NO se cumplió el propósito del sabático

[redacted]
Firma del Jefe de Departamento

10 de marzo de 2026
Fecha

PARA USO DEL CONSEJO DIVISIONAL
El Consejo Divisional, en su Sesión No. ______________ del ______________________________ sobre el Período sabático del interesado acordó que:

☐ Los objetivos SE cumplieron satisfactoriamente
☐ Los objetivos SE cumplieron parcialmente
☐ Los objetivos NO se cumplieron
☐ NO se cumplió el propósito del sabático

____
Secretario del Consejo Divisional

*Además de este formato-resumen, el interesado deberá entregar su Informe detallado de actividades junto con la documentación probatoria correspondiente.

Informe de Sabático 2024-2025 H Vázquez Torres 19180

Descripción de las actividades realizadas

I. Artículos publicados:

1. María Ángeles Vargas-Hernández, Miguel Ángel Vargas, Pedro R. García-Morán, **Humberto Vázquez-Torres**. The Effectiveness of the Havriliak-Negami Model in Predicting the Master Curves of the Asphalt Blends with SBS Triblock Copolymers and Organic Montmorillonite at Different Temperatures and Frequencies. J. Mat. Sci. Chem. Engineering, 12(7), 23-36, 2024. DOI: 10.4236/msce.2024.127003

2. Mónica Stephen Correa-Durán, María Ortencia González-Díaz, Rita Sulub-Sulub, María Isabel de los Dolores Loria-Bastarrachea, José M. Cervantes-Uc, **Humberto Vázquez-Torres**, Manuel Aguilar-Vega. Anionic membranes from vinyl acetate and ionic liquid vinyl-butyl imidazolium (PVAc-co-PVBIT) copolymers: Synthesis, characterization and ionic conductivity. Reactive and Functional Polymers, 208, 106148, 2025. DOI.10.1016/j.reactfunctpolym.2024.106148

3. Jonathan Uriel Hernández-Alonso, María Alejandra Pichardo-Sánchez, Sergio Huerta-Ochoa, Angélica Román-Guerrero, Oliverio Rodríguez-Fernández, Humberto Vázquez-Torres, Roberto Olayo-González, Roberto Olayo-Valles, Luis Víctor Rodríguez-Durán and Lilia Arely Prado-Barragán. Impact of Co-Substrates on the Production of Poly(3hydroxy- butyrate-co-3-hydroxyvalerate) by *Burkholderia thailandensis* E264. *Materials*, *18*(15), 3577, **2025**. DOI.10.3390/ma18153577

4. Stephania Santana-Luna, Marcial Yam-Cervantes, Rita Sulub-Sulub, Mauricio Huhn-Ibarra, **Humberto Vázquez**, Santiago Duarte, Wilberth Herrera-Kao, Maria Ortencia González-Díaz. Sustainable Membranes for Water Treatment from Expanded Polystyrene Waste Using Dimethyl Isosorbide as a Green Solvent. *ACS Sustainable Chem. Eng.* 13, 42, 17939–17948, 2025. DOI: 10.1012/acssuschemeng.5c06312

5. Manuel de Jesús Aguilar-Vega, María Isabel Loría-Bastarrachea, Ángel de Jesús Montes-Luna, **Humberto Vázquez-Torres**, Patricia Pérez-Salinas, and Alberto Rosas-Aburto. Structure, Mechanical, Thermal, Viscoelastic and Tribological Properties of Polymers. Chap. 8. In Polymer Science, Engineering, and Sustainability: Physics, Polymer Characterization, Processing, and Applications, Volume 2, First Edition. Edited by Enrique Saldivar-Guerra and Eduardo Vivaldo-Lima. John Wiley & Sons, New York, 2026.

II. Artículo de divulgación y presentación en congresos

1. Los polímeros en la medicina. Contactos, Revista de Eduación en Cencias e Ingeniería, Núm. 139. Número Especial, 50 Anuversario UAM. ISSN: 2683-2607, Pp. 146-153, 2024.

2. Reconocimiento de presentación en el I Congreso de Biomateriales y Medicina Regenerativa 2024. Cultivo de fibroblastos en membranas de cáscara de huevo.
3. Reconocimiento de presentación en el I Congreso de Biomateriales y Medicina Regenerativa 2025. Preparación de andamios de poli(ácido láctico), PLA, polietiloxazolina (PEOX), electrohilaladas para el cultivo de tejidos celulares.

ACS Sustainable Chemistry & Engineering
pubs.acs.org/journal/ascecg
Research Article

Sustainable Membranes for Water Treatment from Expanded Polystyrene Waste Using Dimethyl Isosorbide as a Green Solvent

Published as part of ACS Sustainable Chemistry & Engineering special issue "Advancing a Circular Economy".

Stephania Santana-Luna, Marcial Yam-Cervantes, Rita Sulub-Sulub, Mauricio Huhn-Ibarra, Humberto Vázquez, Santiago Duarte, Wilberth Herrera-Kao, and Maria Ortencia González-Díaz*

Cite This: https://doi.org/10.1021/acssuschemeng.5c06312 Read Online

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ABSTRACT: This study reports the upcycling of expanded polystyrene (**EPS**) waste into functional membranes for water treatment through direct sulfonation at 3% and 5% (**EPS-3** and **EPS-5**). Successful incorporation of $-SO_3H$ groups was confirmed by FTIR, acid−base titration, and differential scanning calorimetry. Dimethyl isosorbide was identified as the optimal solvent for membrane fabrication due to its balanced viscosity, polymer affinity, and cost-efficiency. The membranes exhibited an asymmetric porous morphology, with the pore size and permeate flux increasing with the sulfonation degree, while total porosity remained close to 74%. Water contact angle decreased from 90.7° for pure **EPS** to 84.9° for **EPS-3** and 71.2° for **EPS-5**, reflecting higher wettability and water uptake (from 2.9% to 11.6%). At 9 bar, the permeate flux increased from 1.01 to 4.83 $L \cdot m^{-2} \cdot h^{-1}$ for EPS-5, and Reactive Black 5 rejection increased from 94 to 97% at 5 bar. Mechanical properties were preserved, with Young's modulus ranging from 146.5 to 127.2 MPa and stable tensile strength. Overall, this study presents a sustainable and cost-effective approach to convert nonbiodegradable EPS waste into valuable membranes for pressure-driven water treatment, simultaneously addressing polymer waste management and water pollution.

KEYWORDS: *upcycling membranes, expanded polystyrene waste, green solvent, dye rejection, sulfonation*

1. INTRODUCTION

Expanded polystyrene is a rigid plastic foam widely used in packaging, insulation, and food containers due to its low cost and desirable physical properties. Global EPS production has averaged around 6.6 million metric tons (MT) annually over the past decade, significantly contributing to environmental plastic waste.[1] Its waste management poses challenges due to its lightness and low-density nature, which make recycling difficult and increase the waste volume.[2] Mechanical recycling is not widely implemented for EPS, and emerging alternatives, such as chemical recycling and energy recovery, remain energy-intensive and costly techniques.[3] Moreover, EPS is ranked as number 6 plastic on the recyclability scale, a category known for its low mechanical recycling feasibility and limited end-of-life options. As a result, their accumulation in landfills and natural ecosystems continues to raise serious environmental concerns. Therefore, revalorization of EPS into high-value products represents a socially and environmentally relevant strategy to divert this problematic waste from conventional disposal routes.

Upcycling offers a promising approach for converting discarded materials into higher-value products. Several studies have explored the use of waste EPS to elaborate polymeric membranes for separation applications, including oil−water separation,[4] air and water nanoparticle filtration,[5,6] and broader water treatment.[7−11]

Despite the upcycling process's sustainability, membrane fabrication involves the use of traditional solvents, such as dimethylformamide (DMF) and *N*-methyl-2-pyrrolidone (NMP), which are highly toxic, potentially carcinogenic, and environmentally harmful. To address this issue and enhance the overall sustainability of membrane production, the use of ecofriendly solvents has been proposed. Several polymers, such as poly(vinylidene fluoride) (PVDF), cellulose acetate (CA), polysulfone (PSf), poly(ether sulfone) (PES), and polyimide (PI), have been fabricated into porous membrane structures by using green solvents. These solvents include Cyrene and its derivatives, dimethyl isosorbide, methyl lactate, succinimide, *N*,*N*-dimethyl lactamide, *γ*-butyrolactone, *γ*-valerolactone, and

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Anionic membranes from vinyl acetate and ionic liquid vinyl-butyl imidazolium (PVAc-*co*-PVBIT) copolymers: Synthesis, characterization and ionic conductivity

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ARTICLE INFO

Keywords:
Anion exchange membranes
Ionic liquid monomer
1-(4-vinylbenzyl)-3-butyl imidazolium tetrafluoroborate
Vinyl acetate
Ionic liquid copolymers

ABSTRACT

Three polymeric anion exchange membranes (AEMs) were synthesized via free radical copolymerization of vinyl acetate (VAc), with ionic liquid monomer 1-(4-vinylbenzyl)-3-butyl imidazolium tetrafluoroborate (VBIT) as the anion-exchange group. VBIT monomer and the copolymers PVAc-co-PVBIT chemical structure at different molar ratios (70:30, 64:36, and 60:40) were characterized by FTIR, ^1H NMR and ^{13}C NMR spectroscopy. DSC and TGA results showed that PVAc-co-PVBIT copolymers exhibit Tg, as well as thermal stability intermediate between the homopolymers. PVAc-*co*-PVBIT membranes showed high water absorption (165–631 %), ion exchange capacity between 2.11 and 2.52 meq g^{-1}, and ionic conductivity between 1.9 and 5.0 × 10^{-2} mS cm^{-1}. In most cases, ionic conductivity (σ) and (*IEC*) values were equal to or higher than those reported for commercial or ionic liquid containing anionic membranes. After exposure to 3 M NaOH alkaline solution, PVAc-*co*-PVBIT membranes remain unchanged with a minimum weight loss. The ability to form membranes, thermal stability, ion exchange capacity and ionic conductivity values of PVAc-*co*-PVBIT copolymers situate them as promising material for anionic membrane preparation.

1. Introduction

Anion exchange membranes, AEM's, are a promising technology for water purification and energy generation, they can be used in processes such as reverse osmosis desalination, electrodialysis and energy production in fuel cells [1,2]. AEMs contain positively charged functional groups in their structure and therefore allow the passage of non-alkaline anions (Cl^-, $-SO_4^{2-}$, PO_4^{3-}), or alkaline anions (OH^-, $HCO_3^{\cdot}$, CO_3^{2-}) [3]. Commercially AEM's are based on quaternary ammonium and bromide doped polymers; however, other groups have been studied such as benzimidazolium, tertiary diamines, sulphonium, aryl-piperidinium and metal cations [4–8]. Ionic liquid (ILs) are a class of salts with bulky asymmetric organic cations and inorganic counteranions that have emerged as a promising material due to their excellent chemical, thermal and electrochemical stability [9,10]. The properties of IL's can be controlled by selection of cation-anion combination and exchange of the counterion. Common ionic liquid cations are: ammonium [11], imidazolium [12], sulfonium [13], triazolium [14], pyridinium [15], phosphonium [16], pyrazolium [17], guanidinium [18], with counter-anions such as bromine (Br^-), iodine (I^-), hexaflourophosphate (PF_6^-), tetrafluoroborate (BF_4^-) and trifluoromethanesulfonate ($CF_3SO_3^-$) [19]. Patil et al. [20] synthesized silver nanoparticles (AgNPs) in four 1-butyl-3-methylimidazolium halide ionic liquids and the test indicated enhanced antibacterial activity observed by the presence of AgNPs in 1-butyl-3-methylimidazolium iodide. Dai et al. [21] prepared catalysts for the production of biodiesel from Jatropha oil based on acidic ionic liquid using 1-methyl-imidazole, 1,3-propyl sulfone, and H_2SO_4. The ionic liquids polymers, abbreviate "PIL's" are polymers either containing or

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8

Structure, Mechanical, Thermal, Viscoelastic and Tribological Properties of Polymers

Manuel de Jesús Aguilar-Vega[1], *María Isabel Loría-Bastarrachea*[1], *Ángel de Jesús Montes-Luna*[1], *Humberto Vázquez-Torres*[2], *Patricia Pérez-Salinas*[3], *and Alberto Rosas-Aburto*[3]

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8.1 Structure of Polymer Chains

A good reason for the widespread use of polymeric materials is that they present physical and chemical properties that are well tuned for different applications at a cost that is quite reasonable. Polymers, as a group of materials, present a wide range of properties, perhaps the largest of all known materials, since they can be found in the form of liquids, soft viscoelastic (rubbery) materials or rigid solids. The wide variety of properties found in polymers are the result of their macromolecular structure since, by definition, they are molecules resulting from the covalent bonding of at least hundreds and up to thousands or millions of basic units. Properties of polymers, as in the case of any chemical compound, are highly dependent on the structure of the polymer chains and the molecular weight resulting from the number of units covalently bonded. Polymer chemical structure affects polymer properties due to the nature of the repeating units that form the macromolecule, the branching and number or crosslinks, as well as differences in the order of the macromolecular units in the case of copolymers (see also Chapter 6 of Volume 1). Some parts and figures of the material included in this chapter were taken from Aguilar-Vega [1].

The molecular weight and the molecular weight distribution determine the molecular size and give a description of the distribution of the different molecular sizes in a polymer [2, 3]. The behavior of polymers in terms of processing depends on the number average molecular weight, M_n, and on the shape of the molecular weight distribution, measured by the molecular weight dispersity (*Đ*). Mechanical properties, such as tensile strength, are limited by short macromolecules, while long chains control the melt flow and elasticity of the processed polymer. Figure 8.1 shows the graph of a typical molecular weight distribution with the four main molecular weight averages commonly determined in a polymer.

For a precise definition of the molecular weight averages shown in Figure 8.1, please see Section 1.1.5.1 of this book.

Đ is calculated as the ratio of M_w/M_n; a value of 1 indicates that the polymer is monodisperse. Depending on the synthetic route, *Đ* can be higher than 2 in step growth polymerization, and as narrow as 1 for anionic polymerization [4]. If diffusion-controlled effects are present, dispersions above 1.5 or 2 are observed in linear free radical polymerization. When branching is present, the value can be much larger (up to 20 or more).

Mechanical properties such as strength under tension are related to M_n, while some others such as melt viscosity are related to a critical M_w, due to an increase in entanglements. M_z is related to viscoelastic properties or melt elasticity during processing [5].

materials

MDPI

Article

Impact of Co-Substrates on the Production of Poly(3-hydroxybutyrate-co-3-hydroxyvalerate) by *Burkholderia thailandensis* E264

Jonathan Uriel Hernández-Alonso [1], María Alejandra Pichardo-Sánchez [1], Sergio Huerta-Ochoa [1], Angélica Román-Guerrero [1], Oliverio Rodríguez-Fernández [2], Humberto Vázquez-Torres [3], Roberto Olayo-González [3], Roberto Olayo-Valles [3], Luis Víctor Rodríguez-Durán [4] and Lilia Arely Prado-Barragán [1,*]

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Abstract

The synthesis of bioplastics from renewable resources is essential for green living. PHBV (poly(3-hydroxybutyrate-co-3-hydroxyvalerate)) is a biodegradable and biocompatible material ideal for various industrial applications. The impact of levulinic (LA), valeric acids (VA), and sodium propionate (SPr) as co-substrates in biomass and the synthesis of 3-hydroxy valerate (3HV) and co-polymerization of PHBV by *Burkholderia thailandensis* E264 (BtE264) was assessed. Thermogravimetric, XRD, NMR, and mechanical characterization were performed on the homopolymer (PHB) and co-polymer (PHBV), and compared to the PHBV-STD. BtE264 produced the co-polymer PHBV when adding any of the three co-substrates. LA showed a higher positive effect on microbial growth (8.4 $g \cdot L^{-1}$) and PHBV production (3.91 $g \cdot L^{-1}$), representing 78 and 22 mol % of 3HB and 3HV, respectively. The PHBV obtained with LA had a melting temperature (Tm) lower than the PHB homopolymer and presented lower values for melting enthalpies (ΔHf); the degree of crystallization and TGA values indicated that PHBV had better thermal stability. Additionally, FTIR and NMR revealed that BtE264 synthesizes PHBV with an organization in monomeric units (3HB-3HV), suggesting differentiated incorporation of the monomers, improving 3.4 times the break elongation the co-polymer's tensile properties. This study highlights the co-substrates' relevance in PHBV synthesis using BtE264 for the first time.

Keywords: *Burkholderia thailandensis* E264; levulinic acid; valeric acid; sodium propionate; biopolymers; PHB; PHBV

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1. Introduction

Since the first synthetic plastic, called "Bakelite" (1907), plastic polymers have had a significant presence in everyday life, with their low production cost, lightness, and dura-