2023「中技社科技獎學金」

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境外生研究獎學金

Research Scholarship for Overseas Students

Self-Healing Cross-linkable Amphiphilic Copolymers: As Applicable Candidates for Various Membrane/Film/Matrix applications

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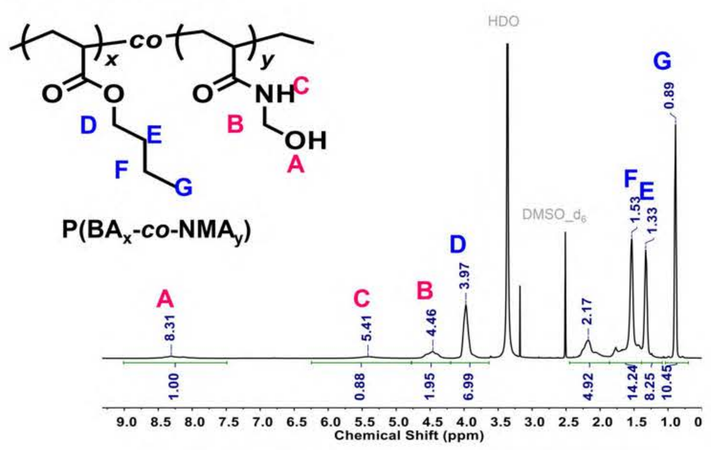
#Advisor

Section 1. Introduction

- ✓ A huge challenge in developing self-healing materials is *achieving a good compromise between mechanical properties and self-healing efficiency*. For this purpose, a facile route is proposed by synthesizing a self-cross-linkable poly{(*n*-butyl acrylate)-*co*-[*N*-(hydroxymethyl)acrylamide]} (PBA_x-*co*-$PNMA_y$) amphiphilic copolymer (AP) prepared by free radical polymerization method, where ***x*** and ***y*** are BA and NMA ratio respectively based on the monomer composition in the copolymer obtained.
- ✓ N-(hydroxymethyl)acrylamide (NMA) was selected as the hydrophilic feature with its rigid characteristics. Owing to the functional groups of −OH, −NH, and a lone electron pair on the C=O groups, NMA merits self-healing capability based on non-covalent interactions through dynamic hydrogen bonds and covalently self-crosslinker via thermal-triggered to achieve the desired mechanical strength and flexibility.
- ✓ *n*-Butyl acrylate (BA) was chosen as a soft segment with a hydrophobic nature, utilized to assist self-healing mechanisms by facilitating the movement of chains in the polymeric network at room temperature and even underwater.
- ✓ This work provides insight into the future design of material with *elastic*, *self-crosslinking*, and *self-healing* properties which are adjustable depending on the desired applications.[1] Such outstanding features with easy control of properties, make these amphiphilic copolymers applicable candidates for various membrane/film/matrix applications such as a dielectric layer, a matrix that is resistant to humid environments, gas separation processes, and so on, where self-healable properties and functionality are highly desired.[2, 5]

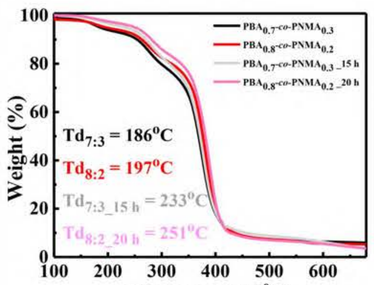
Section 2. Result & Discussion

(a) ^{1}H NMR analysis

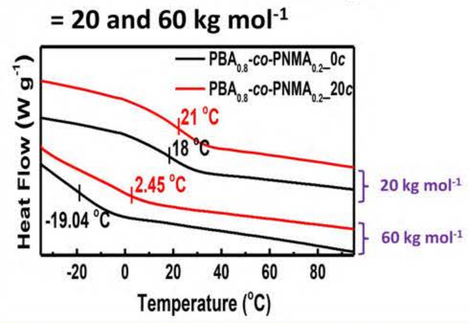


H NMR	BA – (CH_2)	NMA – (CH_2)
Area	3.495	0.975
Ratio	**0.8**	**0.2**

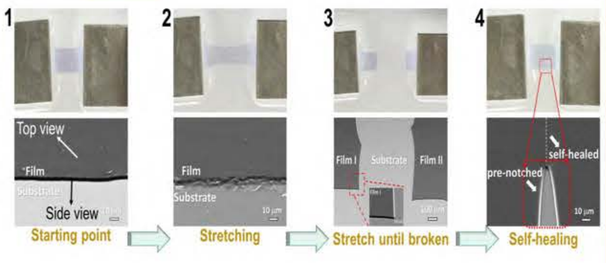
(b) TGA measurement of AP_*Mn* = 20 kg mol^{-1}



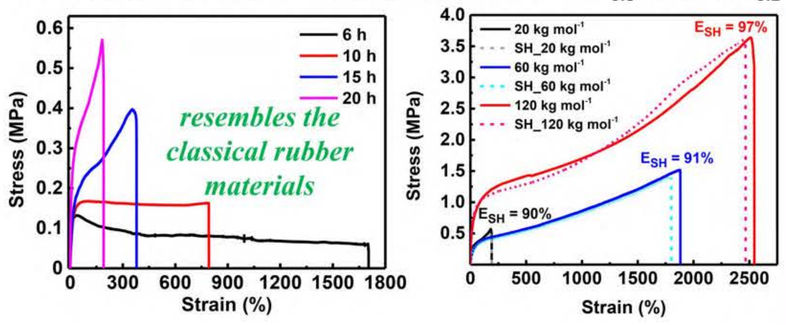
(c) DSC measurement of AP_*Mn* = 20 and 60 kg mol^{-1}



(d) Illustration of optical images and the morphologies of the $PBA_{0.8}$-*co*-$PNMA_{0.2}$ film on the top surface via SEM analysis

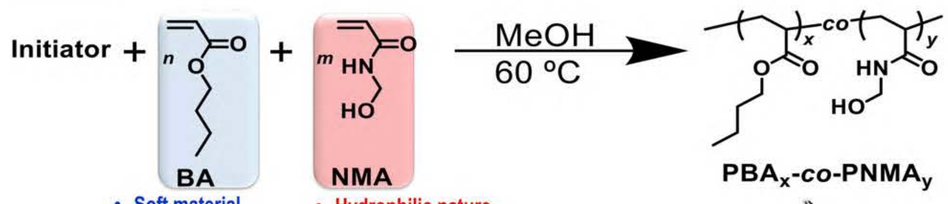


(e) Mechanical and self-healing Properties of $PBA_{0.8}$-*co*-$PNMA_{0.2}$



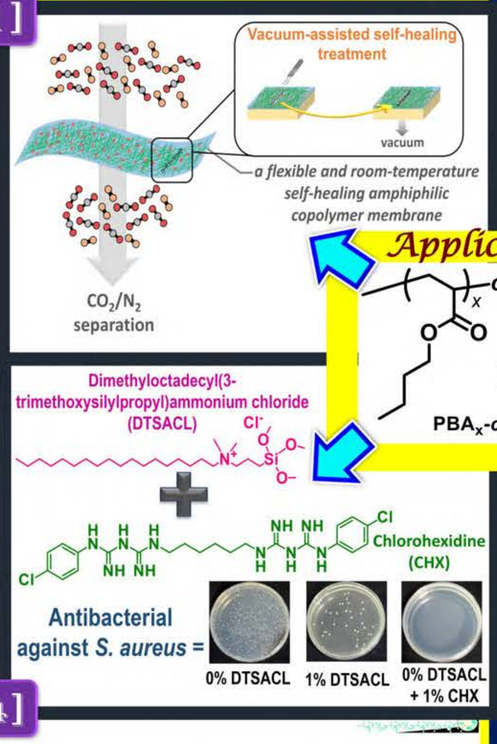
Section 3. Conclusion

In addition:

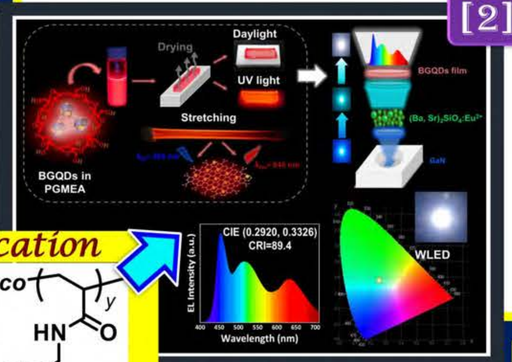


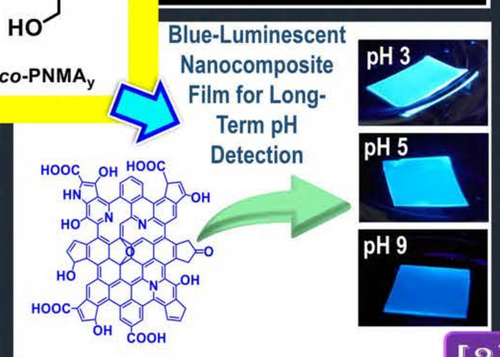
Self-healing Cross-linkable Amphiphilic Copolymers

[1]



[2]





[3]

[4]

- ❑ Soluble in the following types of organic solvents: Methanol, Ethanol, THF, DMSO, Toluene, and PGMEA.
- ❑ With good solubility in various types of organic solvents, the amphiphilic copolymer has the opportunity to be introduced or modified with other compounds, eventually able to maintain the formation of fine thin films.

Section 4. Research Experience

Student Researcher

During Master and Doctoral Studies (2018 – Now)

Polymer Morphology & Electronics Laboratory, National Taiwan University of Science and Technology.

Conducted research projects under the supervision of Prof. Yu-Cheng Chiu.

Topic: [1] Polymer synthesis, processing, and its application in the field of soft electronic devices, with an emphasis on stretchable and self-healable properties. [2] Modification of polymer architecture and functionality. [3] Functional composite design and synthesis, with an emphasis on polymer nanocomposites.

During Bachelor studies (2014 – 2018)

Process Technology laboratory, Widya Mandala Surabaya Catholic University, Indonesia.

Conducted research projects under the supervision of Prof. Ir. Suryadi Ismadji, M.T., Ph.D., IPM., ASEAN Eng. · Ir. as the first advisor and the Dean of the Chemical Engineering Department, Prof. Ir. Felycia Edi Soetaredjo, S.T., M.Phil., Ph.D., IPM., ASEAN Eng. as the second advisor.

Topic: Wastewater Treatment

Section 5. References

1. Chen-Chu Hsu†, Livy Laysandra †, **Yu-Cheng Chiu***, and Wei-Ren Liu*. Pivotal Role of Boron-Doped Graphene Quantum Dots in Stretchable and Self-Healable Red Emission Nanocomposite Film: One Step Advance for White Light Emitting Diodes Application. ***J. Chem. Eng***, 2023, 473, 145469.
2. Yao-Wei Hong†, Livy Laysandra†, **Yu-Cheng Chiu***, and Dun-Yen Kang*. Vacuum-Assisted Self-Healing Amphiphilic Copolymer Membranes for Gas Separation. ***ACS Appl. Mater. Interfaces,*** 2023, 15, 28, 34075–34086.
3. Livy Laysandra†, Darwin Kurniawan†, Chen-Lin Wang, Wei-Hung Chiang*, and **Yu-Cheng Chiu***. Synergistic Effect in a Graphene Quantum Dot-Enabled Luminescent Skinlike Copolymer for Long-Term pH Detection. ***ACS Appl. Mater. Interfaces,*** 2021, 13, 50, 60413 – 60424.
4. Livy Laysandra†, Ching Heng Chuang†, Saburo Kobayashi, Ai-Nhan Au-Duong, Yu-Hsuan Cheng, Yen-Ting Li, Maina Moses Mburu, Takuya Isono, Toshifumi Satoh*, and **Yu-Cheng Chiu***. Design of Self-crosslinkable Poly(*n*-butyl acrylate)-*co*-poly[*N*-(hydroxymethyl)acrylamide] Amphiphilic Copolymers Toward Elastic and Self-Healing Properties. ***ACS Appl. Polym. Mater.***, 2020, 2, 5432−5443.
5. Livy Laysandra†, Yong Jie Fan†, Cecilia Adena†, Yen-Ting Lee, Ai-Nhan Au-Duong, Liang-Yih Chen, and **Yu-Cheng Chiu***. Improving the Lifetime of $CsPbBr_3$ Perovskite in Water Using Self-Healing and Transparent Elastic Polymer Matrix. ***Front. Chem.***, 2020, 8, 766.