Revealing the Metal-Ligand Coordination effects on the Structure modifications for Balanced Tensile Modulus and Self-Healing of Polyurethane Films

Yu-Sheng Lin,[1]Chun-Hsiu Lin,[1] Wei-Ru Wu,[2] Chun-Jen Su,[2]and Ho-Hsiu Chou[,1]*
An-Chung Su[,2], U-Ser Jeng[*,1,2]*
[1]National Tsing Hua University Department of Chemical Engineering
[2]National Synchrotron Radiation Research Center
stam86212@gmail.com

Abstract

Polyurethane (PU) films are potential candidate substrate for current and future stretchable electron devices that attract much attention. Both tensile modulus and self-healing of PU films are anticipated yet seemingly mutual excluded properties. Here, metal-ligand coordination is proposed to modify the crystalline and nanostructural features of PU films for balanced tensile modulus and self-healing. PU films of bpyPTD are prepared from reaction of bpy with PTD of different molar masses in mixed solvent of DMF/THF for linear products of $[bpy(PTN)_nbpy]_m$ with n =19, 34, and 64, and m ~ 6. Metal precursors solutions of Zn, Ni, or Cu, were selectively mixed into the $[bpy(PTN)_nbpy]_m$ solution for cast of the final product films of M-bpyPTD, with M = Ni, Zn, or Cu. X-ray absorption reveals formation of metal-ligand coordination in the PU film. Small-angle and wide-angle X-ray scattering results further indicate that the metal-ligand coordination could form crosslinking centers for locally enriched and partially ordered hard segment domains of a mean spacing of ~ 4nm, thereby resulting in increased Young's modulus. Density (or mean spacing) of the metal-ligand coordination cites could be enriched with reduced *n* value of $[bpy(PTN)_nbpy]_m$ for improved tensile modulus; improvement of the self-healing capability is reached with enhanced metal-ligand coordination strength of bpy with Zn, compared to that with Cu and Ni.

References

[1] W. Z. Mostafa, R.A Hengazy, *Journal of Advanced Research* **2015**, 6, 793-804
[2] G. A. Tabot, S.S. Kim, J. E. Winberry, S.J. Bensmaia, *Neurobiol Dis* **2015**,83, 191-198.
[3] D. Wang, J. H. Xu, *Adv. Funct. Mater.* **2020**, 30, 1907109