Der-Jang Liaw, J Material Sci Eng 2016, 5:2 (Suppl)
http://dx.doi.org/10.4172/2169-0022.C1.010

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Novel Functional Polymeric Nanomaterials : Synthesis, Optoelectronic, Selective Dispersion of SWNTs and Photovoltaics Applications

Novel nanomaterials such as polyimides (PIs), polyamides (PAs), conjugated polymers and polynorbornenes (PNBs) were successfully prepared from various polymerization techniques including low temperature polycondensation, Suzuki coupling and ring-opening metathesis polymerization (ROMP). PIs derived from different architecture designs revealed unique physical-mechanical, electrical and chemical properties. In addition, the PIs films also exhibited high thermal stability (Tg > 300oC), transparency above 90% in visible light region (400-700 nm) and flexibility which are important for optoelectronic applications. PAs with the pyridine moiety displayed good film forming abilities, flexibility, high thermal resistance and yellow emission at 552 nm due to excimer generated by protonation. Conjugated polymers were used for single-walled carbon nanotube (SWCNT) wrapping to separate metallic and semiconducting nanotubes. Their chiralities such as (6,5), (9,5) or (8,7) were identified by photoluminescence-excitation (PLE) maps as well as UV/vis/NIR absorption spectra. Polytriarylamines- or poly(triarylamine-fluorene)-based conjugated polymers with water/alcohol solubility were applied for the hole-transporting materials of solar cells including perovskite solar cells and organic photovoltaics (OPVs). The conjugated polymers and PNBs containing hexa-peri-hexabenzocoronene (nanographene) were well dispersed in cyclohexylpyrrolidone (CHP) by bath sonication and possessed exfoliation emission in PLE maps. PNBs synthesized via ROMP showed excellent transparency (90 %) and high thermal stability (Tgs > 160 oC). Triarylamine-containing polymers had electrochromic properties and capacity for multiple colour change reversibilities. The triphenylamine-alt-fluorene conjugated copolymer with hexaphenylbenzene (HPB) and pyrene as asymmetrical pendant groups showed the strong near-infrared (NIR) electrochromic absorbance attributed to intervalence charge transfer by the incorporation of the HPB moiety. These polymeric materials had high organo-solubility in common solvents and as a result can be used for solar cells, organic field effect transistors, polymer memories, and smart windows applications.

Biography

Professor Der-Jang LIAW, Polymer Science Doctor (Ph.D. Polymer), is currently a Chair professor of Chemical Engineering at National Taiwan University of Science and Technology (NTUST). He holds his Master and Ph.D degrees in polymer science at Osaka University (Japan) and published about 360 SCI papers (h-index = 44 from ISI Web of Knowledge), 180 conference papers and 60 patents. In 2009, he was a recipient of the International Award from the Society of Polymer Science, Japan along with Prof. J. M. J. Frechet (USA) and Prof. K. Muellen (Germany). He received the Outstanding Polymer Academic Research Prize in 2012 and Lifetime Achievement Prize from The Polymer Society of Taiwan in 2013. He has been a fellow of The Polymer Society of Taiwan since 2014 and has been Academician of the Russian Academy of Engineering since 2011.

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