Korean Journal of Chemical Engineering,
Vol.35, No.1, 1-11, 2018

Nanomaterials for bioelectronics and integrated medical systems

Lee YS, Kim JM, Koo JH, KiM TH, Kim DH

Abstract - Biomedical electronic devices integrated with specific human body parts have attracted considerable attention because they present significant breakthroughs to solve various clinical challenges. Recent innovations in soft nanomaterial assemblies, novel device design strategies, and clinically relevant system-level applications have accelerated the rapid growth in this research field. In particular, novel biomedical functionalities, such as extraordinary sensitivity in diagnosis and outstanding therapy performance, could be achieved through wearable, implantable, and minimally invasive bioelectronics. Monolithic integration of functional nanomaterial assemblies with flexible and stretchable device platforms has enabled these breakthroughs. This review first presents a brief history and then provides more details of recent advancements in nanomaterial assemblies and their applications to soft bioelectronics. Important technological advances to solve unmet clinical challenges are presented by leveraging soft bioelectronics toward the next-generation medical systems.

Korean Journal of Chemical Engineering,
Vol.35, No.1, 12-19, 2017

Synthesis, characterization and electrical properties of polypyrrole/V_2O_5 composites

Malook K, Khan H, Shah M, Haque IU

Abstract - Polypyrrole (PPy) and its composites with vanadium pentoxide (V_2O_5) were synthesized in aqueous medium by chemical oxidation polymerization using $FeCl_3 \cdot 6H_2O$ as an oxidant. The materials were characterized by Fourier transform infrared (FT-IR) spectroscopy, X-ray diffractometry (XRD), thermogravimetry analyzer (TGA), scanning electron microscopy (SEM), energy dispersive X-ray (EDX), UV/visible spectroscopic techniques and LCRmeter. The FT-IR results confirmed the successful synthesis of PPy and PPy/V_2O_5 composites. The XRD study showed the amorphous and crystalline nature of PPy and PPy/V_2O_5 composites, respectively. The TGA analysis showed slight increase in the thermal stability of the composites. The SEM data verified the porous nature of PPy and the composites. The UV/visible spectrometry confirmed the doping of PPy in composites. The electrical properties of the materials displayed their semiconducting nature. The resistance of the samples was found to be dependent on temperature and the contents of V_2O_5 in the composites.

Korean Journal of Chemical Engineering,
Vol.35, No.1, 99-109, 2018

Selective transformation of biomass-derived 5-hydroxymethylfurfural into 2,5-dihydroxymethylfuran via catalytic transfer hydrogenation over magnetic zirconium hydroxides

Hu L, Yang M, Xu N, Xu J, Zhou S, Chu X, Zhao Y

Abstract - An economical and effective approach for the selective transformation of biomass-derived 5-hydroxymethylfurfural (HMF) into 2,5-dihydroxymethylfuran (DHMF) was developed by catalytic transfer hydrogenation over various magnetic zirconium hydroxides (MZHs). As expected, MZH with a moderate Zr/Fe molar ratio of 2 displayed the highest catalytic activity, resulting in 98.4% HMF conversion and 89.6% DHMF yield at 150 °C for 5 h in the presence of 2-butanol that simultaneously acted as the hydrogen donor and reaction solvent, which was ascribed to its appropriate specific surface area, pore size and acid-base content. Moreover, a plausible reaction mechanism for the catalytic transfer hydrogenation of HMF into DHMF over MHZ(Zr/Fe=2) was also proposed, in which the basic hydroxyl groups with the aid of acidic zirconium metal centers were considered to be responsible for the pivotal hydride transfer via a six-membered ring structure.

Korean Journal of Chemical Engineering,
Vol.35, No.2, 303-317, 2018

Polymer/graphene oxide (GO) thermoset composites with GO as a crosslinker

Ha HJ, Ellison CJ

Abstract - Composites have historically been of intense interest due to their potential to replace glass, wood and metal at a fraction of the weight. Of the many choices of fillers, graphene oxide (GO) is generally attractive for its versatility and tunability in terms of surface functionality, size and shape. While the majority of GO has been incorporated into polymers and polymer precursors by physical mixing, this review focuses on research where GO has served as both a property enhancer and multifunctional crosslinker in thermosets. Methods for preparing GO (with and without additional functionalization) and incorporating it appropriately into thermosets are described. A review of characterization techniques, typically applied before and after GO is incorporated into thermosets and analytical methods for confirming important chemical reactions during crosslinking, is also provided. Finally, the resulting composite thermoset properties are surveyed throughout to connect preparation and characterization methods to their potential practical importance.

Korean Journal of Chemical Engineering,
Vol.35, No.2, 438-444, 2018

Zirconium-based isoreticular metal-organic frameworks for CO_2 fixation via cyclic carbonate synthesis

Jeong HM, Roshan R, Babu R, Kim HJ, Park DW

Abstract - Two highly stable isoreticular metal-organic frameworks comprising chains of zirconium coordinated with linkers of 1,4-H2BDC (1,4-benzenedicarboxylic acid) and 4,4'-H2BPDC (4,4'-biphenyldicarboxylic acid), denoted as MIL-140A and MIL-140C, were synthesized. The catalytic activity of these frameworks was studied for the coupling reaction of CO_2 and epoxides to produce cyclic carbonates under solvent-free conditions. Excellent activity was observed for both catalysts: they yielded high epoxide conversion with >99% selectivity toward the cyclic carbonate, and were fully reusable even after four cycles without any considerable loss of initial activity. The enhancement in the catalytic activity was explained based on acidity/basicity studies. The influence of various reaction parameters such as catalyst amount, reaction time, reaction temperature, and CO_2 pressure was also investigated. Reaction mechanism was proposed on the basis of experimental evidence and our previous DFT (density functional theory) studies.

Korean Journal of Chemical Engineering,
Vol.35, No.2, 574-578, 2018

Deep-ultraviolet photodetector based on exfoliated n-type β-Ga_2O_3 nanobelt/p-Si substrate heterojunction

Shin GH, Kim HY, Kim JH

Abstract - Low-dimensional semiconductor p-n junctions as components for optoelectronic devices are considered to be more promising than thin film equivalents. We fabricated heterojunction p-n solar blind photodiodes with the configuration of n-type β-Ga_2O_3 nanobelts contacted onto p-Si substrates. The junction between β-Ga_2O_3 and Si was formed by van der Waals interactions. The fabricated heterojunction p-n diodes exhibited typical rectifying current. voltage characteristics, with a rectification ratio as high as 1.56×104 at ±20 V and an ideality factor of approximately eight. Photoresponsive measurements showed that the heterojunction p-n diodes had a high sensitivity and selectivity for light at a wavelength of 254 nm, with fast response and decay characteristics. For the fast-response components, the response time constant was 4.06 s and the decay time constant was 0.16 s. The exfoliated β-Ga2O3 nanobelt/Si p-n heterojunction presented here constitutes a functional unit for low-dimensional ultra-wide bandgap electronic and optoelectronic devices.

Korean Chemical Engineering Research,
Vol.55, No.6, 754-761, 2017

콜로이드 실리카를 이용한 UV 경화형 친수성 코팅 도막 제조

Preparation of UV-Curable Hydrophilic Coating Films Using Colloidal Silica

양준호, 송기창

Abstract - 알코올에 분산된 콜로이드 실리카를 아크릴 단량체인 pentaerythritol triacrylate (PETA)와 혼합시킴에 의해 UV 경화형 친수성 코팅 용액을 제조하였다. 또한 이 친수성 코팅 용액을 PC 기재 위에 스핀코팅 시킨 후 10 min 동안 UV 경화시킴에 의해 친수성 코팅 도막이 제조되었다. 이 과정 중 코팅 용액 중의 콜로이드 실리카 양을 10~50 g으로 변화시켜 코팅 도막의 친수성에 미치는 영향을 살펴보았다. 그 결과 코팅 용액 중의 콜로이드 실리카 양은 코팅 도막의 친수성에 큰 영향을 미치며, 콜로이드 실리카 양이 30 g인 경우에 37°의 가장 낮은 접촉각과 H의 우수한 연필경도를 나타내었다.

Korean Chemical Engineering Research,
Vol.55, No.6, 868-873, 2017

On Compositional Convection in Near-Eutectic Solidification System Cooled from a Bottom Boundary

Hwang IG

Abstract - Natural convection is driven by the compositional buoyancy in solidification of a binary melt. The stabilities of convection in a growing mushy layer were analyzed here in the time-dependent solidification system of a neareutectic melt cooled impulsively from below. The linear stability equations were transformed to self-similar forms by using the depth of the mushy layer as a length scale. In the liquid layer the stability equations are based on the propagation theory and the thermal buoyancy is neglected. The critical Rayleigh number for the mushy layer increases with decreasing the Stefan number and the Prandtl number. The critical conditions for solidification of aqueous ammonium chloride solution are discussed and compared with the results of the previous model for the liquid layer.

Korean Chemical Engineering Research,
Vol.55, No.6, 767-770, 2017

A Simple Method to Make the Quadruple Tank System Near Linear

Lee JT, Kyoung IH, Heo JP, paRK YS, Lim YG, Kim DH, Lee YJ, Yang DR

Abstract - Quadruple tank liquid level systems are popular in testing multivariable control systems for multivariable processes with positive or negative zeros. The liquid level system is nonlinear and it will help to illustrate the robustness of control systems. However, due to nonlinearity, it can be cumbersome to obtain process parameters for testing linear control systems. Perturbation sizes are limited for valid linearized process models, requiring level sensors with high precision. A simple method where the outlet orifice is replaced to a long tube is proposed here. The effluent flow rate becomes proportional to the liquid level due to the friction loss of long tube and the liquid level system shows near linear dynamics. It is applied to the quadruple tank system for easier experiments.