Atchareeya Nopwinyuwong 2014: Development of Polydiacetylene and Silica Nanoparticles-Based Time-Temperature Indicator. Doctor of Philosophy (Packaging Technology), Major Field: Packaging Technology, Department of Packaging and Materials Technology. Thesis Advisor: Associate Professor Panuwat Suppakul, Ph.D. 181 pages.

A novel time-temperature indicator (TTI) based on polydiacetylene (PDA) and silica nanoparticles were investigated and developed to monitor the quality and safety of food products during transportation, distribution and storage. Temperature which is one of the most critical factors can affect to the quality of food products, especially chilled food products. PDA is one of the most interesting conjugated polymers which can induce the color transition from blue to red when exposed with temperature. An incorporation of silica nanoparticles can improve chromic properties of PDA due to ionic interaction with its carboxylic groups at the silica surface. The PDA/$SiO_2$ nanocomposite could clearly show color tone than that of PDA vesicle due to structural stability of PDA. Under ultraviolet light irradiation, PDA/$SiO_2$ nanocomposite could exhibit an intense blue solution. Later on, physical and chemical properties of PDA/$SiO_2$ nanocomposite were investigated. Silica nanoparticle was in the core of PDA vesicle, thus PDA/$SiO_2$ nanocomposite exhibited slightly larger size than PDA vesicle. An addition of amphiphilic polymer could reduce color transition temperature of PDA/$SiO_2$ nanocomposite below 60 °C, thus it could occur at 30-50 °C. The %CR of PDA/$SiO_2$ nanocomposite was higher than that of PDA vesicle. For film formation, concentration of silica nanoparticles, type and concentration of plasticizer, and ratio between Pluronic F127 and plasticizer could affect to color change at different temperatures. The present results show an initial color of plasticized PDA/$SiO_2$ films was purple and they could fast change to red-colored film at higher temperature. The P3-2 formula of plasticized PDA (5mM)/$SiO_2$ (1 and 5% w/v) films could clearly change in color when stored at 5-15 °C. The activation energies ($E_a$) of both TTI responses were 121.32 and 138.99 kJ/mol for concentration of silica nanoparticles at 1 and 5%, respectively. After kept at 4 and 10 °C, $E_a$ of skinless chicken breast quality and TTI responses ($SiO_2$ 5% w/v) were 86.36 and 114.06 kJ/mol, which a difference between them was less than 40 kJ/mol. Moreover, this TTI could fast change in color under non-isothermal condition. The mathematical model of each TTI was established according to the relationships between color changes and time and temperature. Finally, this novel polymer-based TTI used as a reliable device, which could exhibit time-temperature history.

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