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EFFECTIVE ANIONIC UV CURING FOR A THERMALLY DISMANTLABLE PHOTOADHESIVE HAVING DISULFIDE BONDS

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Photo-triggered adhesion is one of important technologies in efficient manufacture of products such as home appliances and electronic components. These products will be dismantled into their parts after use, for reusing and recycling. Today, adhesive materials are required to satisfy both strong adhesive strength and dismantling ability. In my presentation, a thermally dismantlable photo-adhesive system has been proposed. This system utilizes two key reactions, i.e. *base proliferation reaction* and *disulfide-disulfide exchange reaction*. The former is for effective anionic UV curing, or photo-adhesion, and the latter is for thermally dismantlement of adhered parts. *Base proliferation reaction*, proposed by Prof. K. Arimitsu (*K Arimitsu, M Miyamoto, K Ichimura (2000) Applications of a nonlinear organic reaction of carbamates to proliferate aliphatic amines Angew. Chem. Int. Ed. 39(19): 3425-3428.*), is a base-catalysed autocatalytic reaction of chemical compounds named base amplifiers (BAs), to enhance photo-sensitivities of materials for photo-patterning and anionic UV curing with photobase generators (PBGs). Using BA with PBG, photo-triggered *base proliferation reactions* are progressed to generate more basic species than from only PBG, under the same UV irradiation condition. Photo-adhesion is effectively realized by using BAs, because the adhesive strength is based on formation of rigid cross-linked networks resulting from reactions of resins with bases from BAs. In our case, both hard films and adhesion samples were successfully fabricated with a PBG, a bi-functional BA, and a bi-functional epoxy resin, after UV irradiation at a wavelength of 365 nm (5000, 10000, or 20000 mJ cm⁻²) and subsequent postbaking at 160°C for 10 or 30 min. In the adhesion process, photo-triggered *base proliferation reactions* between

PBGs and BAs are caused, followed by addition reactions between generated diamines and epoxy resins. On the other hand, *disulfide-disulfide exchange reaction* is one of equilibrium reactions. This reaction proceeds between two disulfide bonds via radical or ionic process under relative mild conditions, even at room temperature. Disulfide bonds have been integrated into self-healing materials of lower glass transition temperature (T_g). In our case, both a diamine from BA and a bi-functional epoxy resin have a disulfide bond in their chemical structures. The cross-linked networks fabricated with them also have many disulfide bonds, and it was found that the value of T_g was 63°C. Therefore, the adhesive strength is kept at room temperature. However, the strength became weak at 100°C (above T_g), due to the *disulfide-disulfide exchange reactions* as well as thermal relaxation of the cross-linked networks. When a shear force is added to the cross-linked networks with gentle heating, a microscopic stress is added to the disulfide bonds located in the part having high internal stress. Then, these bonds would take their interchange reactions for releasing the stress. This stress relaxation results in separating two cured bulks.

Biography

Masahiro Furutani has completed his PhD in Engineering from The University of Tokyo in 2013. He is now a research associate of Pure and applied chemistry in Tokyo University of Science, working under Professor Koji Arimitsu in the area of UV curing systems of kinds of resins for the applications of coatings and adhesives.

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