변성실리카 도입에 의한 광경화형 점착제의 열 안정성 향상

Improvement of thermal stability of photo curable pressure sensitive adhesive by incorporating vinyl modified silica nanoparticles

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1. Introduction

Pressure-sensitive adhesives (PSAs) are viscoelastic materials that can adhere strongly to solid surfaces upon application of light contact pressure for a short contact time. A balanced combination of tack, peel strength, and shear resistance is of primary concern in PSA production. Along with the replacement of solvent-based systems with waterborne or solventless adhesives, the future would bring the development of hybrid adhesive systems and custom-designed products. The combination of organic polymers and inorganic particles into nanocomposites has attracted considerable attention in recent years, as these materials offer the prospect of new synergetic properties that originate from their organic and inorganic components.[1, 2] Organic/inorganic hybrid particles can be produced by a variety of ways with either ex situ or in situ techniques. Among the number of inorganic/organic materials, silica/polymer composite materials have attracted considerable interest due to their potential use as aerospace materials, structural materials in electronics, sensors, and materials in other industries.[3] Until now, although much research has been done on the preparation of silica/polymer composite materials, the acrylic PSAs have not yet been widely applied as composite structures and the effect of the introduction of silica on the UV curable adhesive properties has not been studied in detail.

2. Experimental

The acrylic copolymer was synthesized with the fixed composition of 2-ethylhexyl acrylate (2-EHA), EA (ethyl acrylate), and AA (acrylic acid) in 41.7, 41.7, and 16.6 wt%, respectively. The acrylic copolymer was synthesized by solution radical polymerization with 1.5wt% AIBN in ethyl acetate at the solid content of 32.5wt%. Organic modification of the silica particles was performed by the grafting of organosilane molecules, γ-methacryloxypropyl trimethoxysilane (MPS), bearing a reactive vinyl group. The MPS-modified silica (MPS–silica) was dispersed in ethyl acetate and then incorporated into the acrylic copolymer structure via UV-curing method.

3. Results

The extent of crosslinking in acrylic PSAs was controlled by varying both the contents of modified silica and the UV dose. Figure 1 represents the effect of both the contents of modified silica and the UV dose on the gel content of acrylic PSAs. The higher gel content was generally obtained for the acrylic PSAs having higher content of modified silica and greater UV dose as expected.

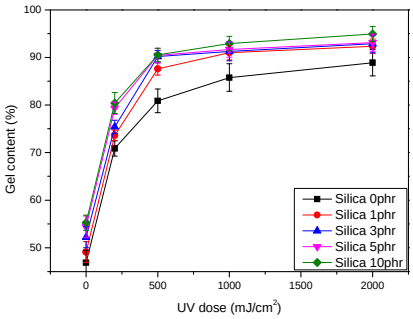

Figure 1. Variations in gel content of acrylic PSAs as a function of the content of modified silica and UV dose.

It was proposed that a polymer resin reinforced with nano-sized inorganic particulates would improve its thermal stability, including the resistances of thermal degradation and flammability. Therefore, the resistance of thermal degradation of the PSAs containing nano-sized silica was expected to be improved. Figure 2 shows the TGA results. The degradation temperature of the PSA increased with the addition of the modified silica in acrylic PSA matrices.

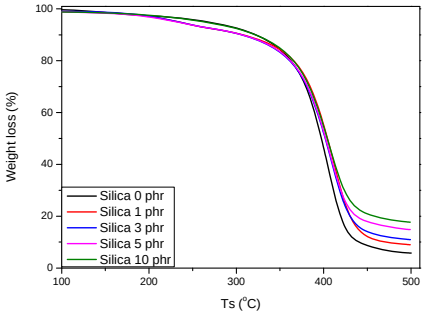

Figure 2. TGA thermograms of acrylic PSAs containing various contents of modified silica nanoparticles after UV curing at 2000mJ/cm^2.

4. Conclusions

The vinyl modified silica nanoparticles were uniformly dispersed in the acrylic copolymer, which was prepared by radical polymerization of EHA, EA, and AA, in order to prepare the acrylic composite PSA films. The extent of crosslinking of acrylic PSAs varied significantly depending on the content of modified silica and UV doses. The acrylic composite PSAs showed the noticeable improvement in thermal stability and elastic deformation characteristics. Both peel strength and probe tack of acrylic PSAs decreased significantly by increasing the content of modified silica and UV dose.

References

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