

# Ultrafast UV-Curable Adhesives for Optical Pick-Ups

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This paper describes novel ultraviolet (UV)-curable adhesives with an ultrafast curing rate which are fully cured within 8 s for optical pick-up (OPU) applications. Two kinds of oligomers (novolac epoxy acrylate and urethane acrylate), additives, and inorganic fillers were prepared for the formulation of the adhesives. In addition, three kinds of photo-initiator [2,2-dimethoxy-2-phenylacetophenone and 2-hydroxy-2-methylpropiophenone for surface curing and (2,4,6-trimethylbenzoyl) diphenyl phosphine oxide (TMDPO) for deep curing] were mixed to increase the curing rate. Photo-differential scanning calorimetry (photo-DSC) analyses showed that the newly formulated UV adhesives had faster curing rate than conventional UV adhesives. The UV adhesives were applied to OPUs for DVD/CD-RW, and five kinds of reliability tests, i.e., thermal shock, low-temperature storage, high-temperature storage, high temperature/high humidity, and nonoperation shock tests, were conducted to evaluate the adhesive reliability. According to the results of reliability tests and thermal stress simulations, the UV adhesives with lower storage modulus ( $E'$ ) showed better thermal shock reliability due to lower thermal stresses. In addition, OPUs assembled using the UV adhesives passed all reliability tests. Consequently, the UV adhesives were successfully applied to OPUs in OPU production lines, contributing to mass production.

**Key words:** UV-curable adhesives, photo-initiator, optical pick-up, DVD/CD-RW, coefficient of thermal expansion, modulus, reliability, photodiode balance

## INTRODUCTION

Ultraviolet (UV)-curable adhesives have been widely used in many applications, such as transparent material bonding, microelectromechanical systems (MEMS) technologies, and optical pick-ups (OPUs), because of their ultrafast polymerization, cure-on-demand properties, solvent-free technology, high chemical resistance, and good adhesion.<sup>1-7</sup> Their material properties, such as curing rate, coefficient of thermal expansion (CTE), storage

modulus ( $E'$ ), and curing shrinkage, are also important for such applications, especially OPU manufacturing, because most components in OPUs are bonded by using them.

OPUs are devices that can read and write data to or from optical data media such as DVDs and CDs (Fig. 1a).<sup>8</sup> Laser beams which are generated from laser diodes (LDs) are projected onto the DVDs and CDs to read or write data, and at the same time, the laser beams are passed through many components such as lenses and mirrors (Fig. 1b). Therefore, the material properties of UV adhesives are important, because main components which affect the direction of the laser beams are bonded to a base by using UV

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