OPTICAL STACK COMPRISING ADHESIVE

BACKGROUND

Various optical adhesives, suitable for use in bonding optical articles or components have been described. Optical film stacks that have been bonded with an optical adhesive have also been described. *Industry would find advantage in optical stacks and methods of bonding having improved properties.*

SUMMARY

In one embodiment, optical stacks are described having a combination of high peel strength and high retained brightness, particularly after aging.

The optical stack comprises a first optical film comprising a plurality of structures comprising an optically active portion designed primarily to provide optical gain and optionally an optically in-active bonding portion disposed on a first surface. The first optical film is bonded to a second optical film with a light-transmissive adhesive layer such that a portion of the structures penetrate the adhesive layer and a separation is provided between the adhesive layer and the first surface. The peel strength of the optical stack is at least 50 grams force/inch. The optical stack exhibits a decrease in optical gain of no greater than 5% when the optical stack is conditioned at 65°C and 95% relative humidity for 200 hours.

In one aspect, there is provided an optical stack comprising a first optical film comprising a plurality of structures comprising an optically active portion designed primarily to provide optical gain and optionally an optically in-active bonding portion disposed on a first surface bonded to a second optical film with a light-transmissive adhesive layer such that a portion of the structures penetrate the adhesive layer and a separation is provided between the adhesive layer and the first surface, wherein the adhesive layer comprises an interpenetrating network of the reaction product of a polyacrylate component and a polymerizable monomer having functional groups and a molecular weight less than 150 g/mole per functional group, the peel strength of the optical stack is at least 50 grams force/inch and the stack exhibits a decrease in optical gain of no greater than 5% when the optical stack is conditioned at 65°C and 95% relative humidity for 200 hours.

The low decrease in optical gain after aging is surmised to be attributed to little or no change of structure penetration into the adhesive layer after aging. This feature is beneficial for bonding various structures, regardless of whether the structures are designed primarily to provide optical gain.

In another embodiment, the optical stack comprises a first optical film comprising a plurality of structures disposed on a first surface bonded to a second optical film with a light-transmissive adhesive layer such that a portion of the structures penetrate the adhesive layer defining an average penetration and a separation is provided between the adhesive layer and the first surface. The peel strength of the optical stack is at least 50 grams force/inch. The penetration increases by no more than 50% when the optical stack is conditioned at 65°C and 95% relative humidity for 200 hours.

The retained brightness and little or no change in penetration is preferably provided by certain cured adhesive layers.

In another embodiment, the optical stack comprises a first optical film comprising a plurality of structures disposed on a first surface bonded to a second optical film with a light-transmissive adhesive layer such that a portion of the structures penetrate the adhesive layer providing a separation between the adhesive layer and the first surface, wherein the adhesive layer comprises an interpenetrating network of the reaction product of a polyacrylate and a polymerizable monomer, the adhesive has an elastic modulus ranging from 100 to 2000 MPa at 25°C.

Also described are methods of making an optical construction such as an adhesively bonded stack of optical films. In one embodiment, the method comprises

providing a protruding structure on a first surface, applying a layer of an adhesive composition to a substrate, contacting the protruding structure with the substrate such that the structure partially penetrates the adhesive forming a separation between the adhesive layer and the first surface; and curing the adhesive composition. The adhesive composition preferably comprises a polyacrylate and a monomer having functional group wherein the molecular weight of the monomer is greater than 100 g/mole per functional group.

In another aspect, there is provided a method of making an optical construction comprising:

providing a protruding structure on a first light-transmissive surface;

applying a layer of an adhesive composition to a substrate wherein the adhesive composition comprises a polyacrylate and a polymerizable monomer having functional groups and a molecular weight less than 150 g/mole per functional group;

contacting the protruding structure with the substrate such that the structure partially penetrates the adhesive forming a separation between the adhesive layer and the first surface; and

curing the adhesive composition thereby forming an interpenetrating polymer network.

Also described is an optical assembly, such as an intermediate construction of an optical stack. The optical assembly comprises a protruding structure on a first surface wherein a portion of the structure comprises an adhesive composition comprising a polyacrylate and a monomer comprising functional groups wherein the molecular weight of the monomer is less than 150 g/mole per functional group.

In each of these embodiments, at least a portion of the first optical film or structures preferably comprise an optically non-active bonding portion that penetrates the adhesive layer. In such embodiments, the optically active structures or portion thereof do not penetrate the adhesive layer.

In each of these embodiments, the adhesive may be characterized by any or combination of various attributes described herein. In one embodiment, the adhesive comprises about 35 wt-% to about 75 wt-% polyacrylate. In another embodiment, the polyacrylate is a pressure sensitive adhesive. In another embodiment, the polyacrylate comprises monomeric repeat units comprising branched C4-C12 alkyl groups, such as isooctyl. In one embodiment, the polyacrylate comprises repeat units derived from acrylic acid. In one embodiment, the polymerizable monomer is an epoxy component and the adhesive composition further comprises a photoactivated cationic initiator. In another embodiment, the polymerizable monomer comprises at least three (meth)acrylate groups and the adhesive composition further comprises a free-radical photoinitiator. In yet another embodiment, the adhesive comprises a (e.g. light transmissive) filler such that the adhesive has a haze ranging from about 2% to 30%.

BRIEF DESCRIPTION OF DRAWINGS

The invention may be more completely understood and appreciated in consideration of the following detailed description of various embodiments of the invention in connection with the accompanying drawings, in which:

FIG. 1 is a schematic side-view of a light directing film;

FIG. 2 is a schematic side-view of a unitary discrete structure partially penetrating an optical layer;

FIG. 3 is a schematic three-dimensional view of a light directing film;

FIG. 4 is a schematic side-view of a light directing film;

FIG. 5 is a schematic side-view of an optical stack;

FIG. 6 is a schematic side-view of a light directing film;

FIG. 7 is a schematic side-view of an optical stack;

FIG. 8 is a schematic side-view of a display system;

FIG. 9 is a schematic side-view of another optical stack;

FIG. 10 is a schematic side-view of an optical system suitable for measuring optical gain;