COPOLYMERS INCLUDING A TRIAZINE GROUP AND COMPOSITIONS INCLUDING THEM

Cross-Reference to Related Application

This application claims priority to U.S. Provisional Application No. 62/017,021, filed June 25, 2014, and 62/017,666, filed June 26, 2014, the disclosures of which are incorporated by reference in their entirety herein.

Background

Fluoropolymers are known to have a variety of useful properties, including cleanability, weather resistance, and chemical resistance. Such beneficial properties render fluoropolymers useful, for example, for a variety of outdoor applications including signage, films or coatings for architectural coverings, and protective coverings for photovoltaic modules.

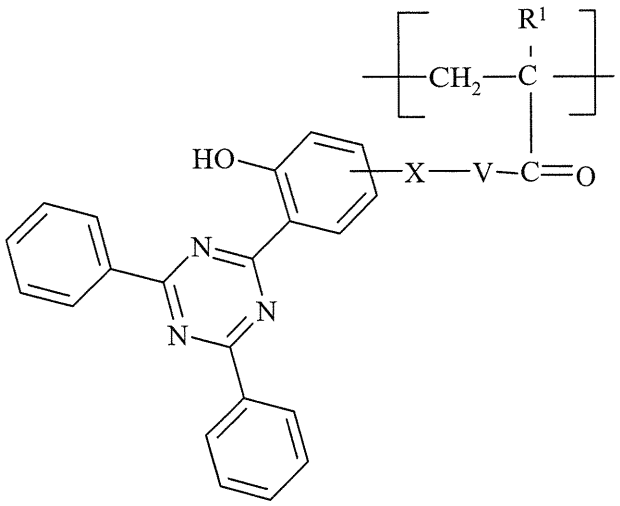
It may be desirable to incorporate ultraviolet absorbers (UVAs) into materials exposed to ultraviolet (UV) radiation, for example, to protect a topcoat or topsheet or an underlying substrate or adhesive from UV degradation. Some UVAs can be dispersed into some compositions, but sometimes they can be lost due to volatilization or migration to the surface. Covalent incorporation of UVAs into certain compositions has been proposed. See, e.g., U.S. Pat. Appl. Pub. No. 201 1/0297228 (Li et al.).

It has been reported that common UVAs can be incompatible with fluoropolymers. See, e.g., U.S. Pat. No. 6,251,521 (Eian et al.). This incompatibility can lead to degradation of physical or optical properties (e.g., loss of clarity or increased fogginess) as well as increased or accelerated loss of the UVA by migration, bleeding, or blooming.

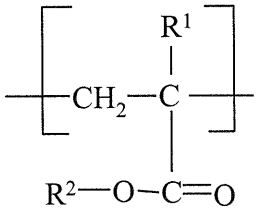
Summary

The present disclosure provides an oligomer having a first divalent unit with a pendent triazine group and compositions that include the oligomer. The composition may include a fluoropolymer. The oligomers are generally quite compatible with fluoropolymers such that the oligomers and fluoropolymers are readily blended together. Compositions including the fluoropolymers and oligomers provide protection from ultraviolet light and have good transparency to visible and infrared light. These properties are surprisingly well-maintained even after accelerated UV exposure and exposure to high temperature and humidity conditions.

The present disclosure provides a composition that includes a blend of a fluoropolymer and an ultraviolet light-absorbing oligomer. The ultraviolet light-absorbing oligomer includes a first divalent unit represented by formula:



and a second divalent unit represented by formula:

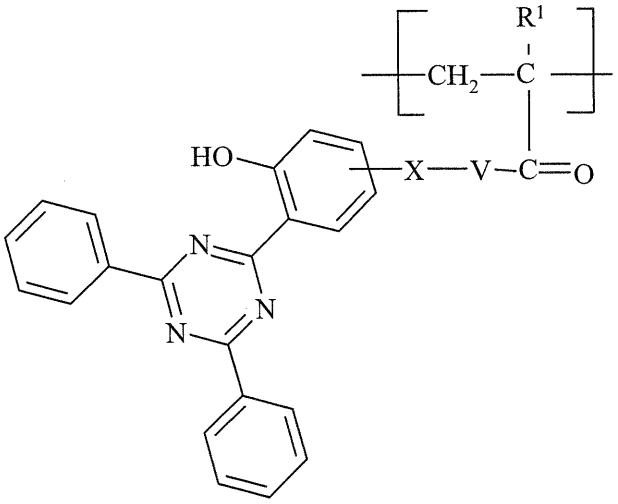


,

in which R^1 is hydrogen or methyl, V is O or NH; X is a bond, alkylene, or alkyleneoxy, wherein the alkylene and alkyleneoxy have from 1 to 10 carbon atoms and are optionally interrupted by one or more -O- groups and optionally substituted by a hydroxyl group, and R^2 is alkyl having from 1 to 4 carbon atoms.

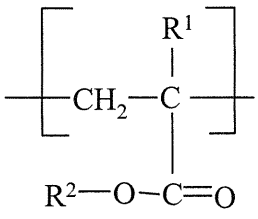
In one aspect, the present disclosure provides a composition comprising a blend of a fluoropolymer and an ultraviolet light-absorbing oligomer, wherein the ultraviolet light-absorbing oligomer comprises:

a first divalent unit represented by formula:



; and

a second divalent unit represented by formula:



;

wherein

each R^1 is independently hydrogen or methyl;

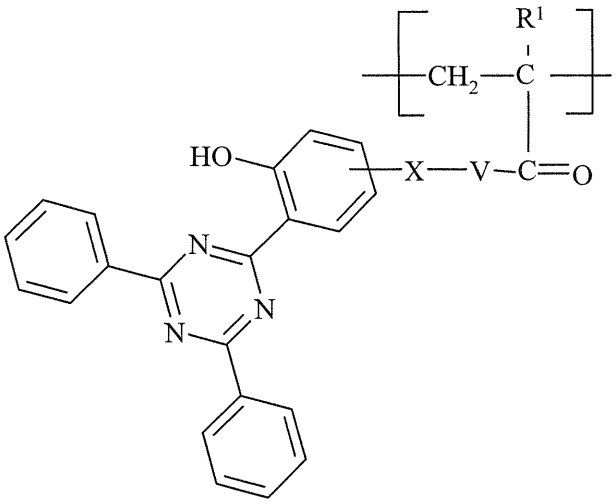
V is O or NH;

X is a bond, alkylene, or alkyleneoxy, wherein the alkylene or alkyleneoxy have from 1 to 10 carbon atoms and are optionally interrupted by one or more –O- groups and optionally substituted by a hydroxyl group; and

R^2 is alkyl having from 1 to 4 carbon atoms.

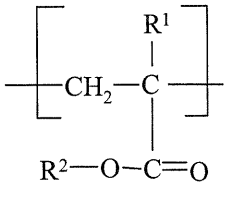
The present disclosure provides an article that includes the composition. The article may be, for example, a photovoltaic device, vehicle wrap, graphic film, architectural film, or window film. In another aspect, the present disclosure provides an article comprising the composition as defined herein, wherein the article is a photovoltaic device, vehicle wrap, graphic film, architectural film, or window film

The present disclosure provides an ultraviolet light-absorbing oligomer including a first divalent unit represented by formula:



; and

a second divalent unit represented by formula:

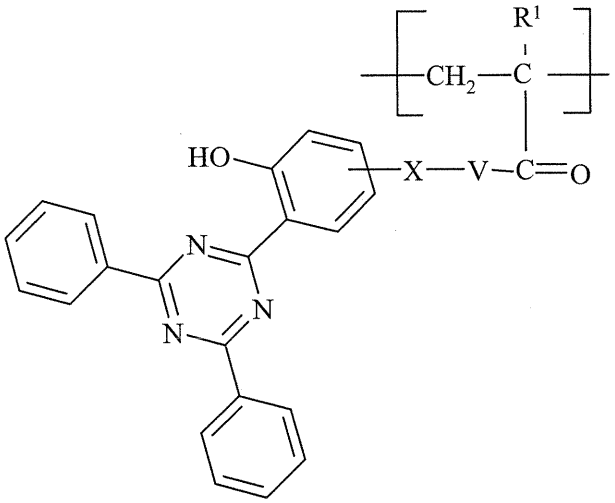


;

in which R^1 is hydrogen or methyl; V is O or NH; X is a bond, alkylene, or alkyleneoxy, wherein the alkylene and alkyleneoxy have from 1 to 10 carbon atoms and are optionally interrupted by one or more -O- groups and optionally substituted by a hydroxyl group; and R^2 is alkyl having from 1 to 22 carbon atoms.

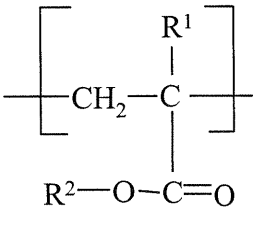
In another aspect, the present disclosure provides an ultraviolet light-absorbing oligomer comprising:

a first divalent unit represented by formula:



; and

a second divalent unit represented by formula:



;

wherein

each R^1 is independently hydrogen or methyl;

V is O or NH;

X is a bond, alkylene, or alkyleneoxy, wherein the alkylene or alkyleneoxy have from 1 to 10 carbon atoms and are optionally interrupted by one or more –O- groups and optionally substituted by a hydroxyl group; and

R^2 is alkyl having from 1 to 22 carbon atoms.

In another aspect, the present disclosure provides a pressure sensitive adhesive including the ultraviolet light-absorbing oligomer.

In fluoropolymer compositions including an ultraviolet light-absorbing oligomer with a first divalent unit having a pendent ultraviolet absorbing group and a second divalent unit, the retention of the ultraviolet light-absorbing oligomers disclosed herein after exposure to ultraviolet light is generally much superior to the retention of conventional ultraviolet light absorbers after exposure to the same conditions. Unexpectedly, the retention of the ultraviolet light-absorbing oligomers after exposure to ultraviolet light generally is remarkably even better when the ultraviolet light-absorbing oligomer disclosed herein is used in comparison to structurally very similar oligomers in which the phenyl groups are substituted.

In this application:

Terms such as "a", "an" and "the" are not intended to refer to only a singular entity, but include the general class of which a specific example may be used for illustration. The terms "a", "an", and "the" are used interchangeably with the term "at least one".

The phrase "comprises at least one of" followed by a list refers to comprising any one of the items in the list and any combination of two or more items in the list. The phrase "at least one of followed by a list refers to any one of the items in the list or any combination of two or more items in the list.

The term "ultraviolet absorbing group" or ultraviolet light-absorbing group refers to a covalently attached ultraviolet absorber (UVA). UVAs are known to those skilled in the art as being capable of dissipating absorbed light energy from UV rays as heat by reversible intramolecular proton transfer. UVAs are selected such that the oligomers in any of the embodiments of oligomers or second oligomers disclosed herein absorbs at least 70%, 80%, or 90% of incident light in a wavelength range from 180 nanometers (nm) to 400 nm.

"Alkyl group" and the prefix "alk-" are inclusive of both straight chain and branched chain groups and of cyclic groups. Unless otherwise specified, alkyl groups herein have up to 20 carbon atoms. Cyclic groups can be monocyclic or polycyclic and, in some embodiments, have from 3 to 10 ring carbon atoms.