FLUOROPOLYMER COMPOSITION INCLUDING AT LEAST ONE OLIGOMER

Cross-Reference to Related Applications

This application claims priority to U.S. Provisional Application No. 62/016,954, filed June 25, 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.

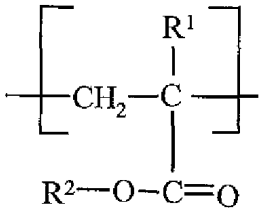
It may be desirable to incorporate ultraviolet absorbers (UVAs) into materials exposed to ultraviolet (UV) radiation, for example, to protect a topcoat or topsheet or an underlying substrate or adhesive from UV degradation. Some UVAs can be dispersed into some compositions, but sometimes they can be 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. 2011/0297228 (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 a composition that includes a fluoropolymer and an oligomer having a first divalent unit with a pendent ultraviolet absorbing group and optionally a third divalent unit that includes a pendent 2,2,6,6-tetramethylpiperidinyl group. Or the composition can include a ultraviolet light-absorbing oligomer with a pendent ultraviolet absorbing group and a second oligomer that includes a pendent 2,2,6,6-tetramethylpiperidinyl group. 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 typically 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 having a pendent ultraviolet absorbing group and a second divalent unit represented by formula:



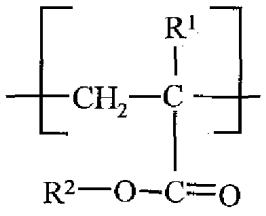
in which R^1 is hydrogen or methyl, and R^2 is alkyl having from 1 to 4 carbon atoms.

At least one of the following is also true: the ultraviolet light-absorbing oligomer further includes a third divalent unit having a pendent 2,2,6,6-tetramethylpiperidinyl group, or the composition further includes a second oligomer having a third divalent unit comprising a pendent 2,2,6,6-tetramethylpiperidinyl group and at least one of the second divalent units. The nitrogen of the pendent 2,2,6,6-tetramethylpiperidinyl group is substituted by hydrogen, alkyl, oxy, alkoxy, or alkanone.

In one aspect, there is provided 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 comprising a pendent ultraviolet absorbing group; and

a second divalent unit represented by formula:



wherein

R^1 is hydrogen or methyl; and R^2 is alkyl having from 1 to 4 carbon atoms,

and wherein at least one of the following limitations is met:

the ultraviolet light-absorbing oligomer further comprises a third divalent unit comprising a pendent 2,2,6,6-tetramethylpiperidinyl group; or

the composition further comprises a second oligomer comprising a third divalent unit comprising a pendent 2,2,6,6-tetramethylpiperidinyl group and at least one of the second divalent units,

wherein the nitrogen of the pendent 2,2,6,6-tetramethylpiperidinyl group is substituted by hydrogen, alkyl, alkoxy, or alkanone.

The present disclosure provides an article that includes the composition. The article may be, for example, photovoltaic device, vehicle wrap, graphic film, architectural film, or window film.

In another aspect, there is provided an article comprising the composition as defined above, wherein the article is a photovoltaic device, vehicle wrap, graphic film, anti-graffiti film, architectural film, or window film.

In some embodiments, the composition is an extruded film. Accordingly, the present disclosure provides a method of making the film disclosed herein. The method includes

combining the fluoropolymer, the ultraviolet light-absorbing oligomer, and optionally the second oligomer to form the blend and extruding the blend into a film.

In another aspect, there is provided a method of making the composition as defined above, the method comprising: combining the fluoropolymer, the ultraviolet light-absorbing oligomer, and optionally the second oligomer to form the blend; and extruding the blend into a film.

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. When the ultraviolet light-absorbing oligomer further includes the third divalent unit having the pendent 2,2,6,6-tetramethylpiperidinyl group and/or when the composition includes the second oligomer including the second and third divalent units, the retention of the ultraviolet-light absorbing oligomers after exposure to ultraviolet light generally is remarkably even better. The 2,2,6,6-tetramethylpiperidinyl group in the oligomers disclosed herein can serve as a hindered amine light stabilizer (HALS), believed to be capable of scavenging free-radicals that can result from photodegradation. The 2,2,6,6-tetramethylpiperidinyl group is thus believed to protect the ultraviolet absorbing group from degradation in the compositions according to the present disclosure, increasing the photodurability of the compositions.

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".