ARTICLE COATED BY A MULTI-LAYER COATING STACK

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Patent Application No. 63/325,870 filed March 31, 2022, and U.S. Provisional Patent Application No. 63/405,147, filed September 9, 2022, the disclosures of which are hereby incorporated by reference in their entireties.

BACKGROUND

Field

[0002] The present disclosure is directed to an article coated by a multi-layer coating stack including, in some non-limiting embodiments, a transparency having the multilayer coating stack on a surface thereof.

Technical Considerations

[0003] Transparencies are included in vehicles and architectural structures to allow a user inside to see out (and vice versa) and to allow light to enter the inside of the vehicle or architectural structure. As a consequence of the sunlight being incident to the transparency, radiative heat transfer between the transparency and the interior of the vehicle or architectural structure can alter the temperature therein, which can be undesirable. Low emissivity coatings applied over transparencies have been developed to reduce the radiative heat transfer between the transparency and the inside. These low emissivity coatings are subject to environmental conditions and can significantly change in color and performance if the coating degrades. Therefore, a need exists to protect the low emissivity coatings.

SUMMARY

[0004] According to one aspect of the disclosure, an article coated by a multi-layer coating stack comprises: the article; and the multi-layer coating stack comprising: a first layer comprising a metal oxide or a metal nitride arranged over the article; a functional layer comprising indium doped tin oxide arranged over the first layer; and a second layer comprising a silicon oxide arranged over the functional layer.

[0005] In some non-limiting examples, the silicon oxide of the second layer may be a silicon aluminum oxide. The first layer may include: an underlayer arranged over the

article, the underlayer including at least one of zinc oxide, tin oxide, zinc-tin oxide, zinc stannate, silicon nitride, or silicon aluminum nitride; and an overlayer arranged over the underlayer, the overlayer including a silicon oxide. The coated article may consist essentially of or consist of: the first layer arranged over the article, the first layer including: an underlayer arranged over the article, the underlayer including at least one of zinc oxide, tin oxide, zinc-tin oxide, zinc stannate, silicon nitride, or silicon aluminum nitride; and an overlayer arranged over the underlayer, the overlayer including a silicon oxide; the functional layer arranged over the first layer; and the second layer arranged over the functional layer, the second layer including a silicon oxide. The coated article may have the following structure: the first layer arranged directly over the article, the first layer including: an underlayer arranged directly over the article, the underlayer including at least one of zinc oxide, tin oxide, zinc-tin oxide, zinc stannate, silicon nitride, or silicon aluminum nitride; and an overlayer arranged directly over the underlayer, the overlayer including a silicon oxide; the functional layer arranged directly over the first layer; and the second layer arranged directly over the functional layer, the second layer including a silicon oxide.

[0006] In some non-limiting examples, the coated article may further include a protective layer arranged over the second layer. The protective layer may include a metal oxynitride layer arranged over the second layer and a metal oxide layer arranged over the metal oxynitride layer, the metal oxide layer may be a titanium oxide, a zinc oxide, a zirconium oxide, a titanium aluminum oxide, a silicon aluminum oxide or a combination thereof. The coated article may consist essentially of or consist of: the first layer arranged over the article, the first layer including: an underlayer arranged over the article, the underlayer including at least one of zinc oxide, tin oxide, zinc-tin oxide, zinc stannate, silicon nitride, or silicon aluminum nitride; and an overlayer arranged over the underlayer, the overlayer including a silicon oxide; the functional layer arranged over the first layer; the second layer arranged over the functional layer, the second layer including a silicon oxide; and the protective layer arranged over the second layer, the protective layer including: a metal oxynitride layer arranged over the second layer; and a metal oxide layer arranged over the metal oxynitride layer, the metal oxide layer including at least one of a titanium oxide, a zinc oxide, a zirconium oxide, a titanium aluminum oxide, a silicon aluminum oxide, or a combination thereof. The coated article may have the following structure: the first layer arranged directly

over the article, the first layer including: an underlayer arranged directly over the article, the underlayer including at least one of zinc oxide, tin oxide, zinc-tin oxide, zinc stannate, silicon nitride, or silicon aluminum nitride; and an overlayer arranged directly over the underlayer, the overlayer including a silicon oxide; the functional layer arranged directly over the first layer; the second layer arranged directly over the functional layer, the second layer including a silicon oxide; and the protective layer arranged directly over the second layer, the protective layer including: a metal oxynitride layer arranged directly over the second layer; and a metal oxide layer arranged directly over the metal oxynitride layer, the metal oxide layer including at least one of a titanium oxide, a zinc oxide, a zirconium oxide, a titanium aluminum oxide, a silicon aluminum oxide, or a combination thereof.

[0007] In some non-limiting examples, the coated article may include glass or plastic. The functional layer may have a thickness of less than 160 nm. The second layer may be substantially free of alumina and a silicon aluminum oxynitride. In one example, the second layer and/or the protective layer may have a thickness of less than 70 nm. In another example, the second layer, the protective layer, and/or the combination thereof may have a thickness from 70-100 nm, such as from 75-97 nm, or from 80-95 nm. The second layer may be the outermost layer. The protective layer may be the outermost layer. The functional layer may be substantially free of silver. The coated article may be mounted in a body of a vehicle or an insulating glass unit.

[0008] According to another aspect of the disclosure, a transparency comprises the coated article as described herein, wherein the multi-layer coating stack is arranged on a surface of the transparency. The coated article includes: the article; and the multilayer coating stack including: a first layer including a metal oxide or a metal nitride arranged over the article; a functional layer including indium doped tin oxide arranged over the first layer; and a second layer including a silicon oxide arranged over the functional layer.

[0009] In some non-limiting examples, the transparency may include a vehicle window, where the multi-layer coating stack is arranged on an inside surface of the vehicle window. The transparency may include an insulating glass unit for an architectural structure. The insulating glass unit may include: a first transparency having a first surface and a second surface; and a second transparency having a third surface and a fourth surface, where a gap is defined between the second surface and