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(54) **LOW-EMISSIVITY GLASS COATINGS HAVING A LAYER OF NITRIDED NICHROME AND METHODS OF MAKING SAME**

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(57) **ABSTRACT**

Low-E glass coated glass articles are comprised of a glass substrate and a multiple layer coating on a surface of the glass substrate. Relatively high light transmissivity of greater than about 72% and satisfactory color characteristics are achieved. The coating includes a layer of a transparent dielectric material adjacent the surface of the glass substrate, and respective layers of nitrided nichrome and silver each of which are formed by sputter-coating onto the glass substrate in a nitrogen-containing atmosphere. Most preferably, the coating also includes a layer of silicon oxynitride interposed between the layer of dielectric material and the layer of nitrided nichrome. The silicon oxynitride layer may include an oxygen gradient layer wherein the concentration of oxygen decreases from one location in the silicon oxynitride layer to another location at a different depth in that same layer. If present, the oxygen gradient is most preferably such that the greater amount of oxygen concentration is nearer the bottom of the layer (i.e., towards the glass substrate) with the lesser amount of oxygen concentration being nearer the top of the layer (i.e., away from the glass layer).

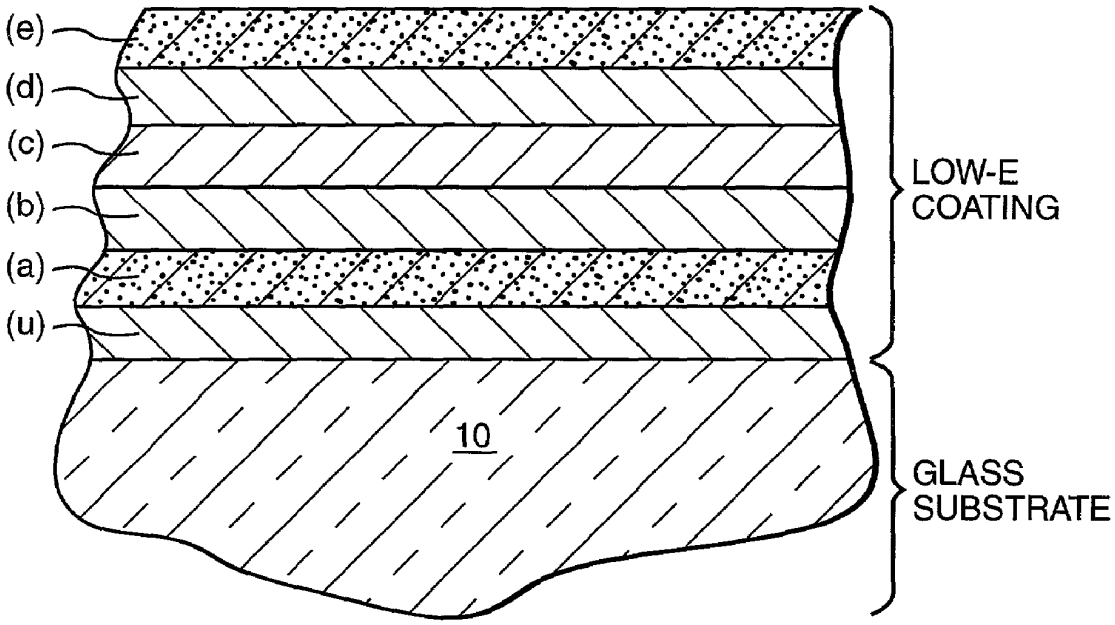
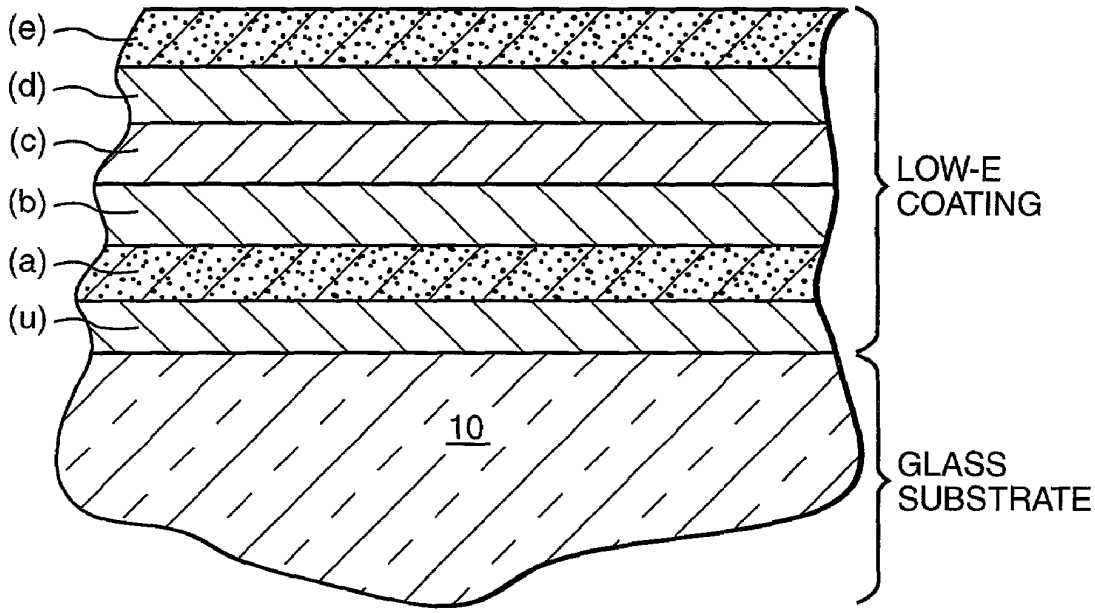


Fig. 1



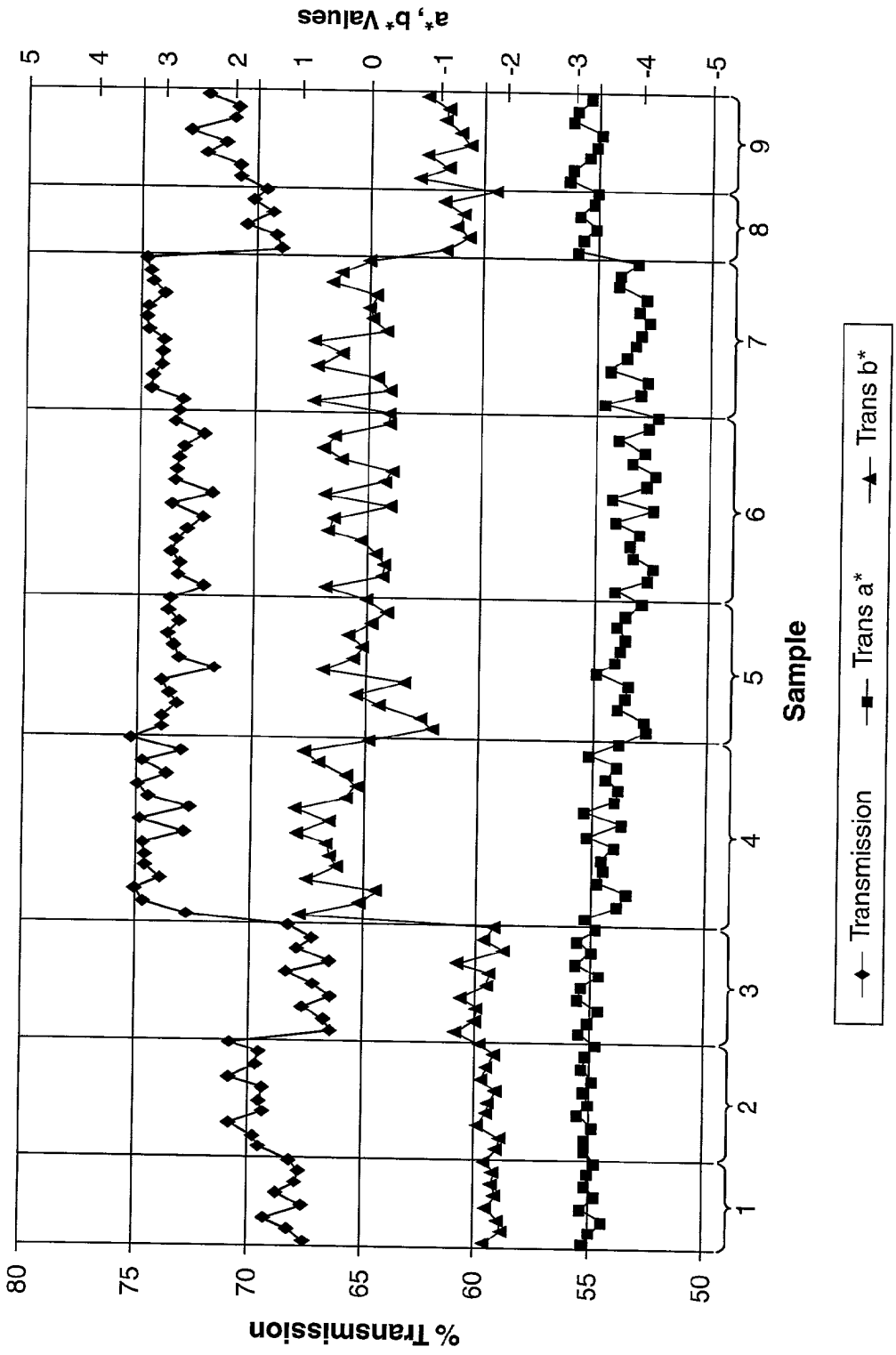


Fig. 2

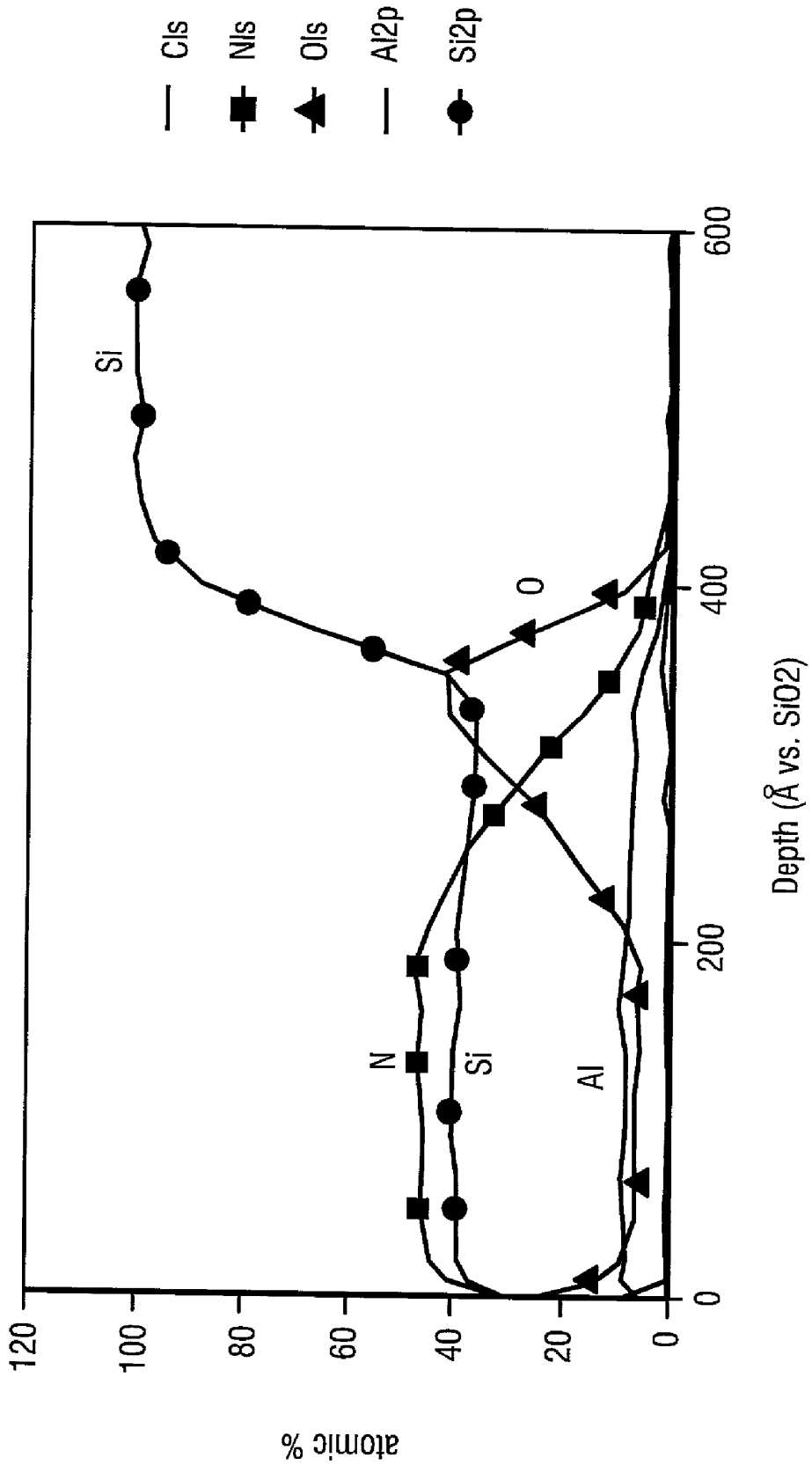


Fig. 3

LOW-EMISSIVITY GLASS COATINGS HAVING A LAYER OF NITRIDED NICHROME AND METHODS OF MAKING SAME

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is based on, and claims domestic priority benefits under 35 USC §119(e) from, U.S. Provisional Application No. 60/187,039 filed on Mar. 6, 2000, the entire content of which is expressly incorporated hereinto by reference.

FIELD OF THE INVENTION

[0002] The present invention relates generally to coatings for glass substrates. More specifically, the present invention relates to glass substrate coatings which exhibit low emissivity (so-called "low-E" coatings) and substantially no color characteristics.

BACKGROUND AND SUMMARY OF THE INVENTION

[0003] Low-E coatings for glass are well known. In this regard, commonly owned U.S. Pat. Nos. 5,344,718, 5,425,861, 5,770,321, 5,800,933 (the entire content of each being incorporated expressly herein by reference) disclose coatings formed of a multiple layer coating "system". Generally, such conventional multiple layer low-E glass coatings have a layer of a transparent dielectric material (e.g., TiO_2, Bi_2O_3, PbO or mixtures thereof) adjacent the glass substrate and a sequence of multiple layers of, for example, Si_3N_4, nickel (Ni), nichrome (Ni:Cr), nitrided nichrome (NiCrN) and/or silver (Ag). These conventional low-E coatings are, moreover, heat-treatable—that is, the coating is capable of being subjected to the elevated temperatures associated with conventional tempering, bending, heat-strengthening or heat-sealing processes without significantly adversely affecting its desirable characteristics.

[0004] While the conventional low-E coating systems disclosed in the above-cited U.S. patents are satisfactory, there exists a continual need to improve various properties of low-E coating systems generally. For example, continued improvements in the durability and/or color (or more accurately, lack of color) characteristics in low-E glass coatings are desired. Improvements in such characteristics are important to ensure that the coatings retain their low-E property for prolonged periods of time (even after being subjected to potentially abrasive environment encountered during the manufacturing process—e.g., the washing and cutting of glass articles having such low-E coatings) and have the desired light transmission properties. It is toward fulfilling such needs that the present invention is directed.

[0005] Broadly, the present invention is embodied in low-E glass coated glass articles comprised of a glass substrate and a multiple layer coating on a surface of the glass substrate, wherein the coating includes a layer of a transparent dielectric material adjacent the surface of the glass substrate, a layer of nitrided nichrome, and a layer of silver which is sputter coated onto the glass substrate in a nitrogen-containing atmosphere. Most preferably, the coating further includes a layer of silicon oxynitride interposed between the layer of dielectric material and the layer of nitrided nichrome.

[0006] These and other aspects and advantages will become more apparent after careful consideration is given to the following detailed description of the preferred exemplary embodiments thereof.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

[0007] Reference will hereinafter be made to the accompanying drawings, wherein like reference numerals throughout the various FIGURES denote like structural elements, and wherein;

[0008] **FIG. 1** is a is a greatly enlarged cross-sectional schematic representation of a surface-coated glass article of this invention which includes a glass substrate and a multiple layer low-E coating system coated on a surface of the glass substrate;

[0009] **FIG. 2** is a graph of % Transmission and transmitted a*, b* Values for glass articles containing a low-E coating of this invention compared against other coatings not within the scope of this invention; and

[0010] **FIG. 3** is a graph showing the concentration, in atomic percent (at. %), of constituents of a $SiAlO_xN_y$ coating on a Si substrate according to Example III, Test Sample 3 below versus the depth of the coating in Angstroms (Å).

DETAILED DESCRIPTION OF THE INVENTION

[0011] Accompanying **FIG. 1** depicts in a schematic fashion one particularly preferred embodiment of the present invention. In this regard, the multiple layer low-E coating of the present invention will necessarily be applied onto a glass substrate **10** which is, in and of itself, highly conventional. Specifically, the glass substrate **10** is most preferably made by a conventional float process and is thus colloquially known as "float glass". Typical thicknesses of such float glass may be from about 2 mm to about 6 mm, but other glass thicknesses may be employed for purposes of the present invention. The composition of the glass forming the substrate **10** is not critical, but typically the glass substrate will be formed of one of the soda-lime-silica types of glass well known to those in this art.

[0012] The process and apparatus used to form the various layers comprising the low-E coating of the present invention may be a conventional multi-chamber (multi-target) sputter-coating system such as that disclosed generally in U.S. Pat. No. 5,344,718 (the entire content of which is incorporated expressly herein by reference). One particularly preferred sputter-coating system is commercially available from Airco, Inc. As is well known, the glass substrate **10** is advanced sequentially through the contiguous chambers or zones which have respective atmospheres to form sputter-coating layers of desired constituency and thickness.

[0013] As depicted in **FIG. 1**, one particularly preferred low-E coating may be formed of the following layers and layer thicknesses (identified sequentially from adjacent the glass substrate **10** toward the outside):

Layer	Constituent	Thickness Range (Å)	Thickness Preferred (Å)
(u)	transparent dielectric	about 100–200	about 125
(a)	silicon nitride (Si_3N_4)	about 25–200	about 125
(b)	nitrided nichrome (NiCrN)	about 2–40	about 10
(c)	silver (Ag)[1]	about 100–200	about 145

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