

CRT WITH CARBON-PARTICLE LAYER ON A METALLIZED
VIEWING SCREEN AND PREPARATION METHOD

5 This invention relates to a novel CRT (cathode-ray tube) having a layer of carbon particles on a metallized viewing screen, and to a method of preparation thereof.

 U.S. Pat. Nos. 3,703,401 (issued 21 November 1972 to Deal et al.) and 4,025,661 (issued 24 May 1977 to Moscony et
10 al.) each disclose a CRT comprising a screen support, a luminescent viewing screen on the support, a light-reflective metal layer on the screen, and a carbon-particle layer of amorphous carbon and/or graphite on the metal layer. The carbon-particle layer may absorb heat that is radiated from an
15 associated aperture mask, or may absorb electrons that are scattered from, or generated by, the electron beam or beams that excite the viewing screen. The carbon-particle layer does not include a permanent binder, although it is usually made using a temporary organic binder which is removed during
20 a baking step designed to oxidize or otherwise volatilize organic matter from all of the layers on the screen support.

 It has been found that the carbon-particle layer is a source of loose particles after the baking step. After the structure is assembled into an operative CRT, such loose
25 particles can lead to problems of high-voltage stability in the CRT. Thus, it is desirable to include a permanent binder in the carbon-particle layer. The above-cited U.S. Pat. No. 4,025,661 points out why a metal-ion residue in the carbon-particle layer is undesirable. Also, any addition to the
30 carbon-particle layer which reduces the luminescent brightness of the screen by more than 5% is undesirable. Thus, the obvious choices of a permanent binder for the carbon-particle layer are unacceptable.

35 A CRT according to the present invention is similar in structure to the above-described prior CRTs, except that the carbon-particle layer ~~contains~~^{has} silica particles as a binder therefor. The ~~preferred~~ silica particles are preformed^{preferably} by pyrolyzing a fumed silicon compound, such as silicon tetra-

chloride, and have an average particle size of less than 0.1 micron. The silica is a dry powder and is to be distinguished from most silica binders which are gelatinous, and from most
5 preformed silica powders which have much larger average particle sizes.

The inventive method is similar to the methods disclosed in the above-cited patents, except for the presence of the preformed silica powders, which may be applied before,
10 during or after the carbon particles are applied, preferably by spraying an aqueous suspension thereof. Thus the silica particles may be a layer under the carbon particles, or mixed with the carbon particles in a single layer, or a layer over the carbon particles. In all cases, the ^{preferred} weight ratio of
15 silica to carbon particles is in the range of 0.9 to 1.1.

The silica and carbon particles are deposited whilst the screen support is at a temperature in the range ^{about} 50°C to 75°C.

In the drawing:

The sole Figure is a partially broken-away longitudinal view of
20 an illustrative CRT according to the invention.

The CRT shown in the sole FIGURE is an aperture-mask-type kinescope of the type described in U.S. Pat. No. 3,423,621 (issued 13 May 1974 to Royce). The CRT includes an evacuated envelope 21, which includes a neck 23 integral with a funnel 25, a faceplate pannel 27
25 comprising a viewing window 27A and an integral peripheral sidewall 27B which is joined to the funnel 25 by a seal 29 of devitrified glass. A luminescent viewing screen 31 comprising a mosaic of line or dot areas of different luminescent emission colors resides on the inner surface of the viewing window 27A. A
30 light-reflecting metal layer 33 of aluminum metal resides on the screen 31, and a carbon-particle layer 35 resides on the metal layer 33. An electron-gun mount assembly 37 is located in the neck 23. Three metal fingers 39 space the mount assembly 37 from the neck wall and connect the
35 mount assembly 37 with an internal conductive coating 40 on the inner surface of the funnel 25. Closely spaced from the metal layer 33 is a metal aperture mask 41. The mask 41 is welded to a metal frame 43 which is supported by springs 47 on studs 45 which are integral with the panel 27. An electron beam or beams from the mount assembly 37, when suitably scanned on the screen 31, is capable of producing

1 a luminescent image which may be viewed through the window
27A. Except for the carbon-particle layer 35, the structures and methods of making are described in detail elsewhere and need not be redescribed here.

5 The carbon-particle layer 35 is about 0.0025 mm (0.1 mil) thick and consists essentially of about equal-weight parts of preformed colloidal silica particles and carbon particles (in the form of amorphous carbon and graphite) per unit area. The carbon-particle layer 35 may
10 be prepared by the following typical procedure, after the aluminum metal layer 33 has been vapor deposited on the screen 31 and before organic matter is removed from the structure. A first suspension has the following formulation:

68.2 grams colloidal graphite such as Aqua Dag E* (22%
15 solids) marketed by Acheson Colloids Company, Port Huron, MI,
15 grams amorphous carbon (average particle size about 0.021 micron), such as Vulcan XC-72* marketed by Cabot Corporation, Boston, MA,
20 1.5 grams dispersant, such as Marasperse CBX-2* marketed by Reed Lignin Company, Rothschild, WI,
0.3 gram wetting agent, such as Brij 35* marketed by ICI Americas Inc., Wilmington, DE,
1,915 grams deionized or distilled water.

25 This formulation is mixed in a dispersator for about 15 minutes. The first suspension is then blended for 5 minutes in a dispersator with an equal volume of the following second suspension:

15 grams colloidal silica (average particle size about
30 0.014 micron), such as Cab-O-Sil M-5* marketed by Cabot Corporation, Boston, MA,
985 grams deionized or distilled water.

The resultant mixed suspension is ready to be applied to the aluminized screen by spray application.

35 The panel and intermediate structure thereon are placed in an oven that is preheated to about 85° to 95°C and kept there for about 15 minutes, until the panel is at about the oven temperature. The panel is removed from the oven, and the panel seal lands and the inner sidewalls of

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1 the panel including the mask-mounting studs are masked, as
with a shield, to about the mold match line, but the entire
viewing area is left unmasked. Then, with the panel still
preheated, an aqueous dispersion of a volatilizable
5 film-forming material is sprayed upon the unmasked aluminum
metal layer. A preferred dispersion that is substantially
free from substances which, when incinerated, yield
metal-ion-containing residues is prepared by mixing 250
10 milliliters of an aqueous acrylic resin emulsion (contain-
ing about 46-weight-percent solids) and 14 grams PVP
(polyvinyl pyrrolidone) with 2050 milliliters deionized
water. A preferred acrylic resin emulsion is Rhoplex
AC-234* marketed by Rohm and Haas Company, Philadelphia, PA,
which is believed to be constituted principally of ethyl
15 acrylate copolymerized with minor amounts of acrylic and
methacrylic monomers and polymers. The spraying is conducted
for about 1 to 3 minutes with an air-spray gun operating at
about 3.5kg/cm^2 (50-pounds-per-square-inch) pressure, and
includes about ten passes of the spray across the surface. The
20 sprayed material dries in less than a minute, due in part
to the heat in the preheated panel, forming a sealer coating
or barrier layer.

Then, with the panel still preheated above about 50°C (e.g. in
the range 50°C to 75°C), and the shield in place, the above-described
25 mixed suspension comprising particles of silica, graphite and carbon
black is sprayed upon the unmasked portions of the coated
metal layer. The spraying is conducted for about 2 to 5
minutes with an air-spray gun operating at about 3.5kg/cm^2 (50
pounds-per-square-inch) pressure and includes about twenty
30 passes of the spray across the surface, to provide a coating
weight of about 0.15 mg/cm^2 . The sprayed material dries in
less than a minute, due in part to the heat in the preheated
panel, and forms a heat-absorptive overcoating.

The shield is removed, and the coated panel is now
35 processed in the usual way. This includes the usual step of
baking the panel in air at about 400° to 450°C to remove, by
vaporization and oxidation, the volatile and organic matter
in the structure. In this last baking step, the film and
coating of volatilizable material underlying and overlying

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1 the aluminum metal layer, the binders in the mosaic viewing
screen, and all of the dispersing agents and wetting agents
in the structure are removed. After baking, the structure
includes an aluminum-metal reflective layer on the phosphor
5 mosaic viewing screen and a heat-absorptive silica-and-
carbon-and-graphite overcoating adhered upon the aluminum
layer.

There are many variations that may be made to the
above-described example that fall within the scope of the
10 inventive method. Many of these variations are disclosed in
the above-cited U.S. Pat. Nos. 3,703,401 and 4,025,661 and
need not be redescribed here.

Either graphite or amorphous carbon or a combina-
tion of the two may be used for the carbon in the overcoat-
15 ing. Amorphous carbon may be in the form of lamp black,
carbon black or other forms prepared from the incomplete
burning of carbon-bearing materials. The graphite may be
synthetic or natural. It has been observed that graphite
particles are more resistant to oxidation and tend less to
20 penetrate the viewing screen than the amorphous carbon par-
ticles. Amorphous carbon particles produce layers that are
more heat absorptive and are less resistant to electron
penetration. A mixture of the two types of carbon is
preferred.

25 The particle size of the carbon particles is not
critical, but is preferably colloidal in size, to facilitate
the preparation and maintenance of a suitable suspension
and to minimize electron beam attenuation. The carbon may
be suspended in any liquid vehicle that does not adversely
30 affect the phosphor screen. However, it is preferred to
disperse the carbon in water. When carbon particles are
dispersed in water, it has been found desirable to include
wetting and dispersing agents for the purpose of producing
a stable suspension. Also, it has been found desirable to
35 omit organic binders for the particles from the suspension.
When binders have been included, it has been found that
the carbon particles may oxidize excessively during the
subsequent baking step, thereby making the process control
more difficult.

1 The particles of silica are preformed and need to
be less than 0.1 micron in size, with an average size well
below 0.1 micron. Suitable silica particles are prepared
by pyrolyzing fumed silicon compounds to produce the desired
5 material. A commercially-available family of suitable
silicas is marketed by Cabot Corp., Boston, MA under the
name Cab-O-Sil.* Silicas that are made by grinding or
precipitation in a wet medium are believed to be unsatis-
factory. The silica particles are suspended in a liquid
10 vehicle suitable for air spraying or other methods of
application.

 The suspension of silica may be mixed with the
suspension of carbon particles and deposited on the metal
layer as described in the example. The structure produced
15 is designated A in the Table. Alternatively, the silica
suspension may be deposited on the metal layer, and then
the carbon-particle layer may be deposited on the silica-par-
ticle layer. The structure produced is designated B in the
Table. Alternatively, the carbon-particle layer may be
20 deposited on the metal layer and then the silica-particle
layer deposited on the carbon-particle layer. The structure
produced is designated C in the Table. In any of these
structures the weight ratio of silica particles to carbon
particles per unit area in the finished CRT is about 0.9 to
25 1.1. It is noteworthy that some of the weight of carbon
particles is lost by oxidation during the processing of the
CRT.

 Relative tests were run on the above-described
structures and, as a control, on a similar prior structure
30 having a carbon-particle layer (no silica present) on the
metal layer, which is designated D in the Table. In the
Table, the relative luminescent light output of the viewing
screen of each operating CRT was obtained by comparison with
the light output from an operating CRT having a noncoated
35 light-reflective metal layer whose light output was con-
sidered to be 100%. Relative particle generation was
determined by violently pounding the inverted panel and
counting the relative numbers of particles released.
Relative emissivity is determined by measuring the relative

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1 absorption of infrared radiation at the surface of the structure. This data shows that trade-offs can be made by the design of the structure and still be within the teaching of the invention.

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Table

	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>
Light Output %	97.6	93.4	98.6	97.5
Particle Generation	Good	Best	Poor	Poor
Emissivity	0.62	0.68	0.59	0.60

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CLAIMS

1. A cathode-ray tube comprising a screen support,
a luminescent viewing screen on said support, means for
5 exciting said screen to luminescence with at least one elec-
tron beam, a light-reflective layer of metal on said screen,
and a layer of particles of graphite and/or amorphous carbon
on said light-reflective layer,

said carbon-particle layer having preformed silica
10 particles less than 0.1 micron in average size as a binder therefor and
being substantially free from metal-ion residue .

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2. A tube as defined in claim 1, wherein the weight
ratio of said silica particles to said carbon particles is in
the range of 0.9 to 1.1.

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3. A tube as defined in claim 1 or 2, wherein said
25 carbon particles and said silica particles are present in a
single substantially-uniform mixture.

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4. A tube as defined in claim 1 or 2, wherein said
particles are present as a composite of sublayers including
a sublayer of carbon particles deposited on said light-re-
35 flective layer, and a sublayer of silica particles
deposited on said sublayer of carbon particles.



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5. A tube as defined in claim 1 or 2, wherein said particles are present as a composite of sublayers including a sublayer of silica particles deposited on said light-reflective layer, and a sublayer of carbon particles deposited on said sublayer of silica particles.

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6. A tube as defined in any preceding claim wherein said viewing screen comprises a mosaic of areas of different emission colors, said tube including a metal mask spaced from said screen and having therein an array of apertures in register with areas of said screen.

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7. A tube as defined in any preceding claim wherein said silica is a dry powder produced by pyrolyzing a fumed silicon compound.

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8. A tube as defined in claim 1, wherein said carbon particle layer is formed by deposition with said screen support preheated to temperatures in the range of 50°C to 75°C.

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9. A method of making a cathode-ray tube having a screen support, a viewing screen thereon, and a light-reflective metal layer on said screen, wherein the steps subsequent to producing said screen comprise

(a) preheating said support with said screen and metal layer thereon to a temperature in the range of about 50°-75°C,

(b) depositing upon said preheated metal layer a film of organic heat-volatilizabile material, and

(c) depositing on said film a layer of carbon particles and preformed silica particles which is substantially free from metal-ion residue and in which the silica particles are less than 0.1 micron in average size.

10. A method as defined in claim 9, wherein said carbon particles and said silica particles are deposited from a substantially-uniform aqueous suspension thereof.

11. A method as defined in claim 9, wherein said carbon particles are deposited on said metal layer from an aqueous suspension thereof, and then said silica particles are deposited on said carbon particles from an aqueous suspension thereof.

12. A method as defined in claim 9, wherein said silica particles are deposited on said metal layer from an aqueous suspension thereof, and then said carbon particles are deposited on said silica particles from an aqueous suspension thereof.



1 13. A method as defined in claim 9, 10,
11 or 12 wherein the said particles are deposited
by spraying.

5 14. A method of making a cathode ray tube
substantially as hereinbefore described with
reference to the drawing.

10 15. A cathode ray tube made by the method
of anyone of claims 9 to 14.

15 16. A cathode ray tube substantially as
hereinbefore described with reference to the
drawing.

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