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Dielectric support rod for a traveling-wave tube.

A dielectric support rod for a traveling-wave tube has a core (10) of boron nitride coated with a dielectric (11). The dielectric has a secondary electron emission ratio of 1 or more, when primary electrons of eE (eV) are incident thereon, where E (V) is the voltage between the cathode and the RF circuit of the traveling-wave tube, and e (Coul) is the charge on an electron. The dielectric to be coated on the surface can be alumina or beryllia. The rod does not then become negatively charged such as to cause the track of the electrons to become unstable.

FIG. 3B

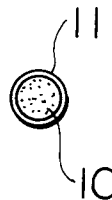
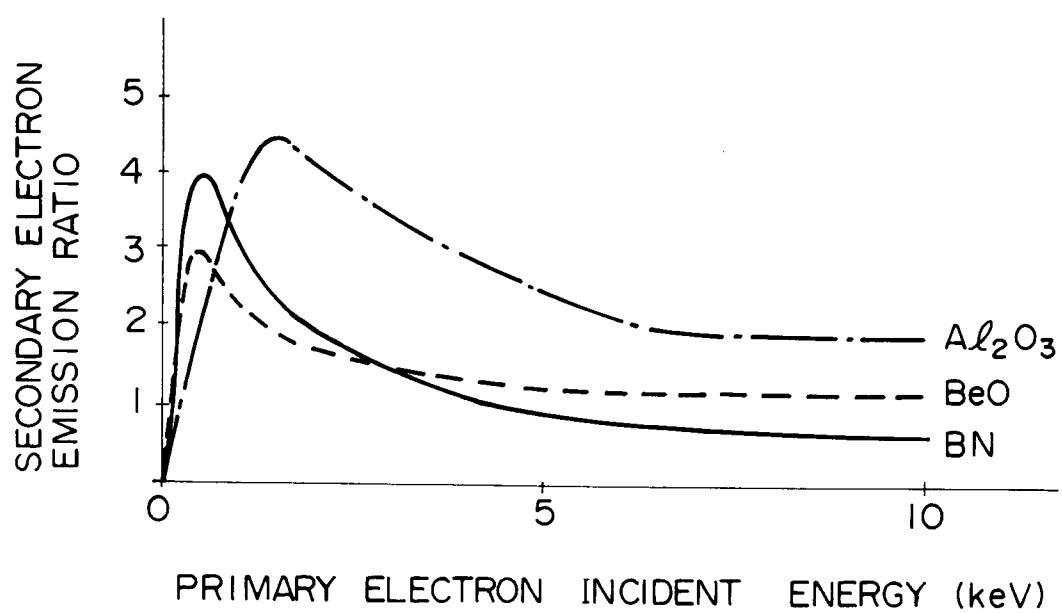


FIG. 4



BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to a dielectric support rod of a traveling-wave tube and, more particularly, to an anti-charge structure of the dielectric support rod.

DESCRIPTION OF THE PRIOR ART

A traveling-wave tube has a RF circuit for causing a RF component and an electron beam to interact with each other so as to amplify the RF component. In a helix or ring loop type traveling-wave tube, a RF circuit is supported in a vacuum sealing metal pipe generally by three dielectric support rods.

Figs. 1A and 1B show the structure of a RF circuit used in a conventional helix type traveling-wave tube. A RF circuit 2 is supported in a vacuum sealing metal pipe 3 by dielectric support rods 1. More specifically, the RF circuit 2 is generally supported by the three dielectric support rods 1 spaced apart from each other at an equal angular interval of 120° so that the RF circuit 2 is supported in the metal pipe 3. Figs. 2A and 2B show a conventional dielectric support rod. The conventional dielectric support rod material is alumina (Al_2O_3) or beryllia (BeO). However, in recent years, in order to improve efficiency of the traveling-wave tube, boron nitride (BN) having a low dielectric constant has been used. Boron nitride, however, may be charged by an electron beam passing through the RF circuit to cause a change in potential, thereby forming an unstable electron beam track. In the worst case, the RF circuit may be damaged.

In order to prevent boron nitride from being charged, a thin carbon coating is formed on the surface of a boron nitride dielectric support rod 1 to cause charges to flow to the RF circuit or the vacuum sealing metal pipe through the coating layer according to a conventional technique.

This carbon coating causes an increase in RF loss to decrease the output or gain of the traveling-wave tube, resulting in inconvenience.

SUMMARY OF THE INVENTION

According to the present invention, there is provided a dielectric support rod for a traveling-wave tube, which supports an RF circuit of said traveling-wave tube, and has a coating thereon, characterized in that the coating on said rod comprises a dielectric having a secondary electron emission ratio of not less than 1 when primary electrons of eE (eV) are incident thereon, where E (V) is the voltage between a cathode and said RF circuit of said traveling-wave tube, and e (Coul) is the charge on an electron.

The dielectric to be coated on the surface is pre-

ferably alumina or beryllia.

Since the secondary electron emission ratio is 1 or more, the dielectric support rod is not negatively charged. Even if the dielectric support rod is positively charged, the potential of the dielectric support rod is increased to re-attract secondary electrons to the dielectric support rod, resulting in a small amount of positive charge. This positive charge does not disturb the track of the electron beam passing through the RF circuit.

In addition, charging is also suppressed by means of the outer coating layer even when electron beam bombardment occurs. Also, the peripheral potential is not much changed to prevent disturbance of the electron beam track.

The Joule loss is eliminated to prevent a decrease in gain and output of the traveling-wave tube.

The above and other objects, features, and advantages according to the present invention will be apparent to those skilled in the art from the following detailed description of the preferred embodiments conforming with the principle of the present invention in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figs. 1A and 1B are a longitudinal sectional view and a side view, respectively, showing the structure of a RF circuit portion of a traveling-wave tube;

Figs. 2A and 2B are a front view and a cross-sectional view, respectively, showing a conventional dielectric support rod;

Figs. 3A and 3B are a front view and a sectional view, respectively, showing a dielectric support rod according to an embodiment of the present invention; and

Fig. 4 is a graph showing the secondary electron emission ratio of each dielectric as a function of the primary electron incident energy.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Several preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings (Figs. 3A, 3B, and 4).

Fig. 3A and 3B show the first embodiment of the present invention. A thin alumina coating 11 having a thickness of about 5nm is formed on a boron nitride dielectric support rod 10.

Fig. 4 shows the secondary electron emission ratios of boron nitride and alumina.

Assume that a voltage E (V) between a cathode and a RF circuit of a traveling-wave tube is 10 kV. In this case, electrons emitted from the cathode and accelerated pass through the RF circuit with a kinetic energy of 10 keV, and some electrons are incident on

the dielectric support rod. When the dielectric support rod consists only of boron nitride, the secondary electron emission ratio of the dielectric support rod is less than 1, as is apparent from Fig. 4. The dielectric support rod accumulates electrons and is negatively charged to decrease the peripheral potential. Therefore, the track of the electron beam passing through the RF circuit becomes unstable.

On the other hand, when the dielectric support rod has a structure obtained by forming an aluminum coating on boron nitride, as shown in Figs. 3A and 3B, the secondary electron emission ratio is 1 or more even if electrons having a kinetic energy of 10 keV are incident, as is apparent from Fig. 4. The dielectric support rod is not negatively charged. Although the dielectric support rod may be positively charged, the potential of the positively charged dielectric support rod is increased to re-attract the secondary electrons. The positive charge amount is small enough not to disturb the track of the electron beam passing through the RF circuit.

In the dielectric support rod having the structure obtained by coating alumina on boron nitride, charging is also suppressed by electron beam bombardment, and the peripheral potential is not much changed, thereby preventing the disturbance of the electron beam. In addition, since alumina is a dielectric, a Joule loss caused by a carbon coating can be prevented, and a decrease in gain and output of the traveling-wave tube can be prevented.

The second embodiment of the present invention exemplifies a beryllia coating formed on a boron nitride dielectric support rod in place of an alumina coating. When the beryllia coating is used in a traveling-wave tube as in the first embodiment, charging is expected to be prevented, and the disturbance of the electron beam track is also expected to be prevented, as can be apparent from Fig. 4. In addition, since beryllia has a larger heat conductivity and a smaller dielectric constant than those of alumina, the heat dissipation effect and efficiency of the traveling-wave tube better than those in the first embodiment can be expected.

Note that the alumina and beryllia dielectric coatings are formed in accordance with CVD (chemical vapour deposition) or ion plating.

Claims

1. A dielectric support rod for a traveling-wave tube, which supports an RF circuit of said traveling-wave tube, and has a coating thereon, characterized in that the coating on said rod (10) comprises a dielectric (11) having a secondary electron emission ratio of not less than 1 when primary electrons of eE (eV) are incident thereon, where E (V) is the voltage between a cathode and said RF cir-

cuit of said traveling-wave tube, and e (Coul) is the charge on an electron.

2. A dielectric support rod according to claim 1, wherein the dielectric to be coated on said surface is alumina.
3. A dielectric support rod according to claim 1, wherein the dielectric to be coated on said surface is beryllia.
4. A dielectric support rod according to claim 1, 2 or 3, wherein the rod is formed of boron nitride.
5. A traveling-wave tube containing an RF circuit supported by one or more dielectric support rods, the or each dielectric support rod being a dielectric support rod in accordance with any of claims 1 to 4.

FIG. 1A
PRIOR ART

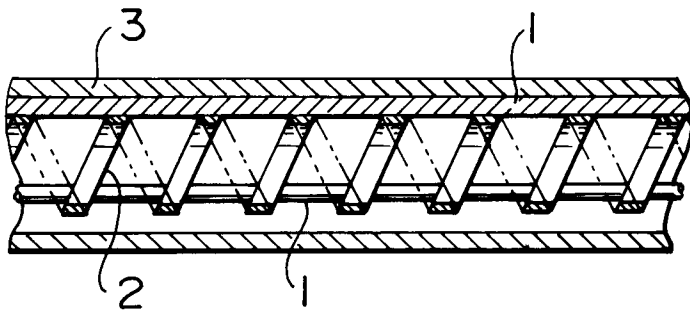


FIG. 1B
PRIOR ART

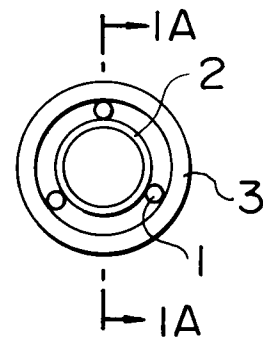


FIG. 2A
PRIOR ART

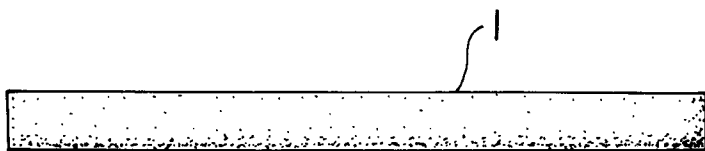


FIG. 2B
PRIOR ART



FIG. 3A



FIG. 3B

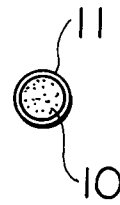
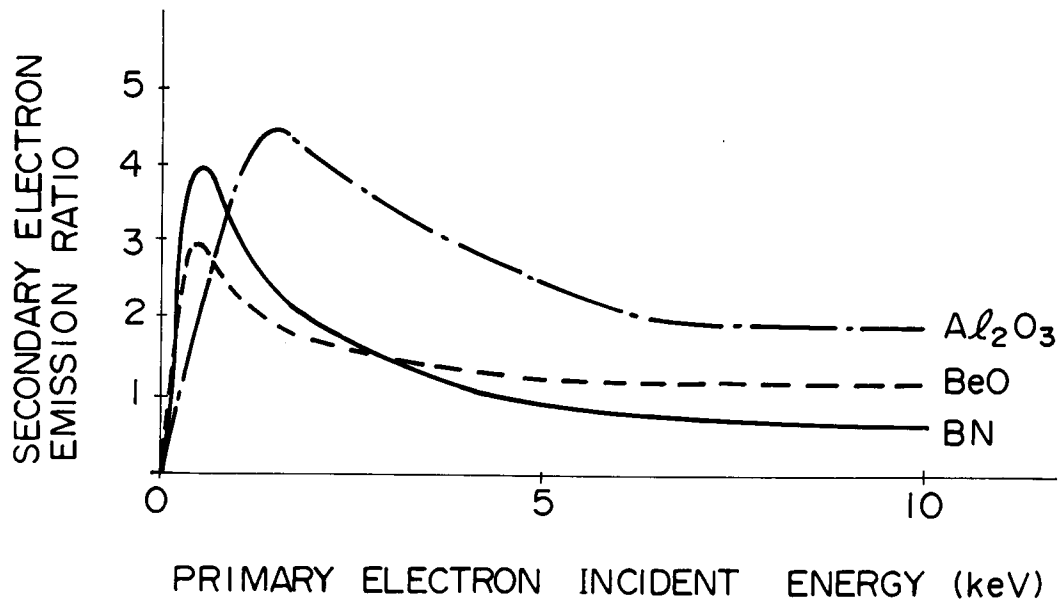


FIG. 4





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

EP 92 30 8726

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	EP-A-0 402 549 (THOMSON-CSF) * abstract * * column 3, line 12 * ---	1-5	H01J23/26
X	FR-A-2 646 732 (RAYTHEON COMPANY) * abstract * ---	1,3-5	
Y	DE-A-3 235 753 (SIEMENS AG) * abstract; figure 2 * ---	1-5	
Y	CH-A-326 748 (SIEMENS & HALSKE AKTIENGESELLSCHAFT) * page 2, left column, line 11 - line 20; figure 2 * ---	1-5	
Y	US-A-3 466 494 (EICHIN) * abstract * -----	1-5	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			H01J
Place of search THE HAGUE		Date of completion of the search 07 JANUARY 1993	Examiner MARTIN Y VICENTE M.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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