Cathodoluminescent Source of Intense White Light

This device is expected to have a long operational lifetime.

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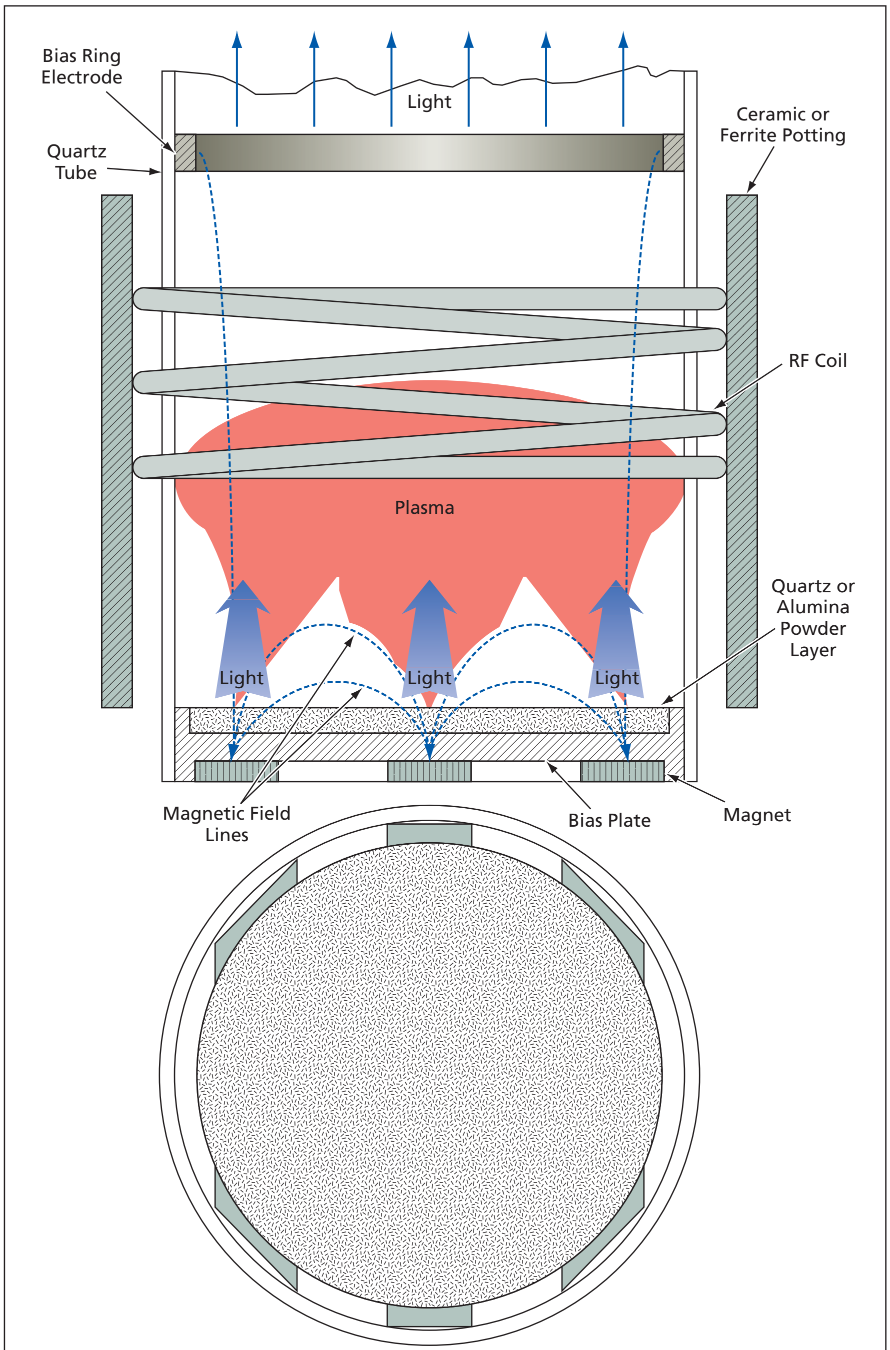
The device shown in the figure exploits cathodoluminescence to generate intense light in the visible and near-infrared regions of the spectrum. This device is suitable for use as a source of white light for general illumination or microscopy or as a broad-band light source for spectroscopy. Unlike incandescent lamps, which typically contain hot filaments, or high-pressure-gas electric-discharge lamps, this device would operate without exposing any of its components to high temperatures. Consequently, the lifetime of this device is expected to be considerably longer than the lifetimes of the aforementioned other light sources.



Electrons From the Plasma are channeled by the cusped magnetic field and accelerated toward the bias plate by the bias electric field. The impingement of the energetic electrons on the layer of quartz or alumina powder excites luminescence.

In general, cathodoluminescence occurs when a covalent or ionic material is exposed to a flux of energetic electrons. The emission of light is feeble when the kinetic energy of the incident electrons is low. One could increase the emission of light significantly by accelerating electrons to high kinetic energy (necessitating the use of high accelerating voltage). Alternatively, one could increase the luminescence by using moderately energetic electrons and taking measures to channel the electron flux appropriately. As described below, this alternative approach is taken in the design of the present device.

In this device, the material to be excited to luminescence is a layer of quartz or alumina powder on an electrically conductive plate exposed to a low-pressure plasma discharge. The plate is electrically biased positively to collect electron current.

The application of radio-frequency (RF) excitation via a coil that surrounds the quartz tube, shown in the figure, sustains the low-pressure plasma discharge. This plasma plays the role of a plasma cathode, which makes it possible to overcome the space-charge limitation encountered in the use of a hot-filament cathode or an electron gun. The electrons are extracted from the plasma via a plasma sheath at the surface of the powder-containing electrode.

The device utilizes magnets to form a cusped magnetic field that channels electrons into three areas on the layer of luminescent material. The luminescence from these areas is intense, even at bias potentials less than 1 kV. Moreover, though the emission is non-thermal, the effective blackbody temperature of the luminescence spectrum is well in excess of the blackbody temperatures of conventional incandescent-filament light sources.

This work was done by John E. Foster of Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-17704-1.