Glenn Research Center
Cleveland, Ohio 44135

Technical Support Package

Cathodoluminescent Source of Intense White Light

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Technical Support Package

for

CATHODOLUMINESCENT SOURCE OF INTENSE WHITE LIGHT

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NASA Tech Briefs

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For additional information regarding research and technology in this general area, contact:

Glenn Technolgy Transfer Office
Mail Stop 4-2
21000 Brookpark Road
Cleveland, OH 44135

Telephone: (216) 433-3484
E-mail:*TTP@grc.nasa.gov*

Cathodoluminescent Source of Intense White Light

Brief Abstract

The device described herein generates broad spectrum electromagnetic radiation in the visible. The device is novel in that it generates broad spectrum radiation that makes it applicable to commercial lighting applications or for spectroscopy applications. The device is also scalable making it applicable to a wide range of lighting applications.

Section I — Description of the Problem

Light sources emitting with a black body-like profile in the visible is desirable from a lighting standpoint. The human eye is most receptive to this wavelength distribution. In general, the perfect source of such radiation is the sun. Common incandescent lights attempt to mimic this profile. The difficulty lies in the fact that to achieve the desired emission, the filament must operate at temperatures in excess of the melting point of the material. (Sun Photosphere temperature ~6,000K) The invention described herein exploits cathode-luminescence emission to form a continuous band due to solid state transitions. This circumvents the need to operate at high temperatures and yet still provide light acceptable to the eye. The problem of non-ideal white light sources transcends general lighting applications. Optimized white light sources are also used in microscopy and spectroscopy. As the device is solid state, its lifetime is expected to be considerably longer than filament based or high pressure discharge light sources.

Section II — Technical Description

The light source described herein utilizes the process of cathode luminescence to generate intense white light. The light emitted has been found to be broad band and intense. In general cathode-luminescence occurs when a covalent or ionic material is exposed to energetic particle flux. The energetic particle flux can generate lattice vacancies by displacing (knocking out) ions in the crystal lattice. The vacancy left behind can be occupied by an electron if the ion displaced is electronegative. The electron occupies the lattice site and is for all practical purposes a substitute ion that can undergo electronic transitions. Excitation and subsequent de-excitation (natural decay due to finite lifetime or collision) gives rise to the emission of light. Such is emission is feeble at low incident electron energies. The invention described here circumvents the need to utilize very high energy electrons by utilizing magnetic cusp that channel electrons into the substrate that subsequently emits the light. Quartz and alumina substrates have been successfully utilized. The electron source used in the proto-type is provided by a RF excited argon plasma, which plays the e role of plasma cathode. The plasma cathode approach allows high electron flux to be collected at the substrate thereby circumventing space charge limitations that would be associated with for example an electron gun. Conventional electron gun sources are inherently space charge limited and would generate fewer dislocations and excitations per unit time than the approach utilized here. Here ions from the plasma coupled with the large electric fields existing in the plasma sheath at the substrate allows for high electron throughput.

Section III — Unique or Novel Features

The device represents a novel approach to solid state lighting for illumination and spectroscopy. Unique attributes are listed below.

A. Novel features:

1. Approach utilizes a discharge plasma as the source of electrons (this reduces space charge limit via presence of ions and intense electric field at the sheath located at the substrate). The high electron flux translates into intense emission.

2. Process utilizes very low voltages to achieve intense luminescene (< 1 kV)

3. The process utlizes magnets to intensify and concentrate electron flux so as to enhance intense emission.

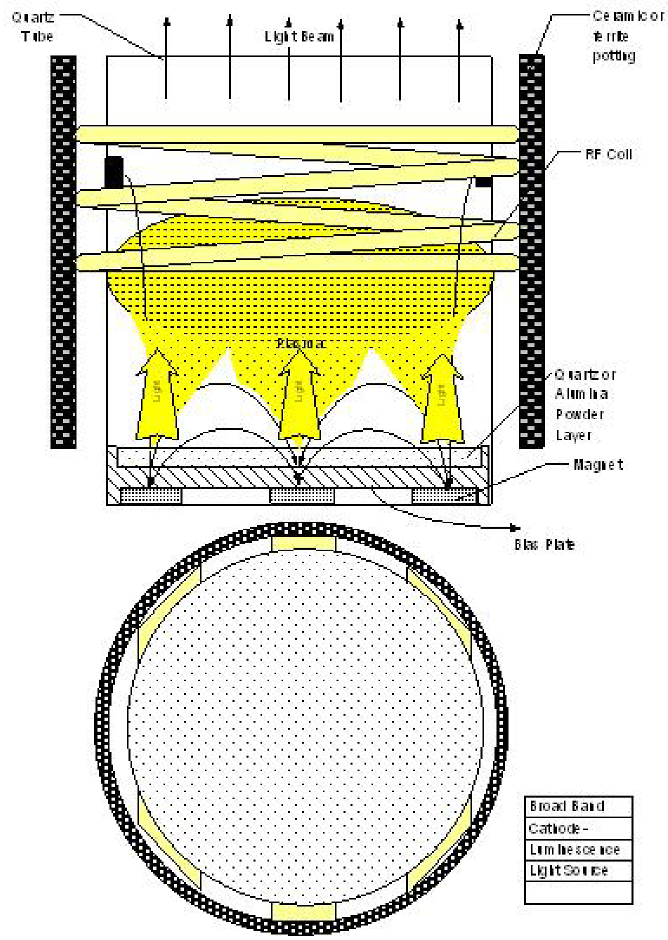
4. The resulting spectrum is broad band extending over the visible and into the near infared which makes it very desirable for commencial lighting type applications and spectroscopy

5. The effective black body temperature of the light source is indeed very high, well in excess of conventional filments.

Section IV — Potential Commercial Applications

The device described here has commercial applications in essentially two general areas:
Commercial lighting: Could be used for decorative lighting, under-cabinet type lighting applications, back lighting for electronic devices such as hand-held PDA, laptop monitors, and desktop LCD monitors.

Spectroscopy applications: White light source would find application in area of spectroscopy.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