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CATHODOLUMINESCENCE AND PHOTOLUMINESCENCE CHARACTERISTICS OF RUBY

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The ruby samples were grown by the Czochralski technique. We used as starter materials Al_2 O_3 powder of 99.99% doped with 1% of Cr_2O_3. The monocrystals obtained were clived to form samples of 5X5X2 mm^3 size. The X-ray diffraction pattern shows a rhombohedral structure type. The elemental composition was determined by EDS. The samples were irradiated with a power from 0 to 15 KV to observe the different impurities levels of emission and the saturation power. The photoluminescence spectra showed two band at 697 and 772 nm, respectively .

1 Introduction

Ruby is an attractive spectroscopy material because its luminescence emission lies in the visible range, property induced by the chromium doped to material in small quantities. The ruby possesses an unusually favorable combination of relative narrow line width [1], a long fluorescent lifetime, high quantum efficiency and broad and well located absorption bands in 265nm and 365nm.

This paper report the ruby cathodoluminescent and photoluminescence properties as a function of incident electron power, and two exciting photon wave lengths.

2 Experimental Development

The ruby samples were grown by Czochralski technique [2,3]. The starter materials were powders of aluminum and chromium oxides with 99.99% of purity. The chromium oxide concentration was about 0.13% has determined by electron dispersion spectroscopy (EDS). The grown crystals were cut to form rectangular samples with 5X5X2 mm^3 dimensions. In order to determine the crystalline structure (rhombohedral) of the samples, X-ray diffraction patterns were obtained using an X-Ray diffractometer Siemens D5000. The cathodoluminescent spectra was obtained using a Spectrofluorimeter Perkin Elmer LS50B, at a electron beam power of 2-15 KV in step of 1 KV. The photoluminescent spectra was determined using the same equipment at 265 nm and 365nm, respectively.

3 Results and Discussion

The typical X-ray diffraction pattern corresponding to the ruby sample is shown in Fig.1. The sample was milled with an agate mortar to the grade of fine powder to obtain the typical peaks corresponding to the corundum □ alumina powder.

The ruby composition indicate 63.13% of atomic oxygen, 36.75% of aluminum and 0.13% of chromium as determined by EDS.

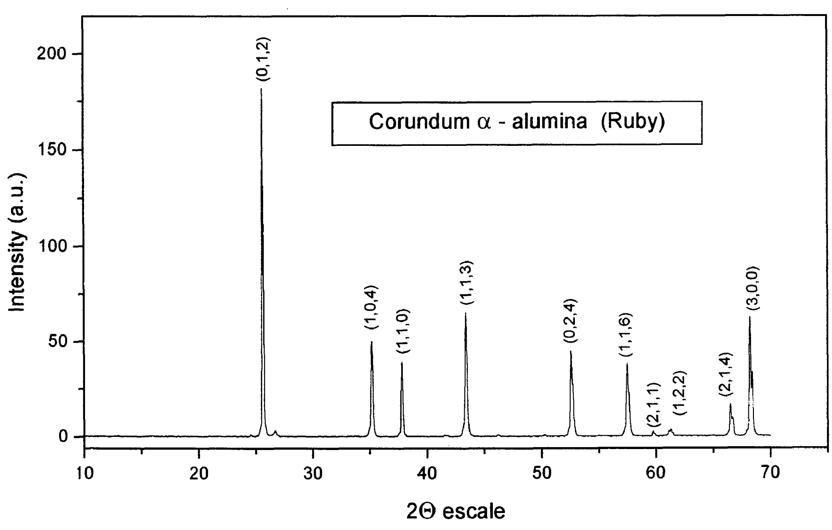

Figure 1. X-ray diffraction pattern of typical ruby

The Fig.2 shows the emission spectra at 14 KV of electron beam power. Only one broad band is observed, centered at 695 nm. This peak correspond to the transition ^2E - $^4A_2$ of the chromium ion. The dependence of the emission intensity as a function of electron beam acceleration voltage is shown in Fig.3.This dependence is characterized by: $Lcl = F(Ib)\,(V\text{-}Vo)^m$, where Vo is the dead voltaje, Ib is the electron beam current, V is the acceleration voltage and $1<m<2$ is the potential dependence of the function. In this case Vo = 2Kv, Ib = 5mA, and m has a value of about 1.1.

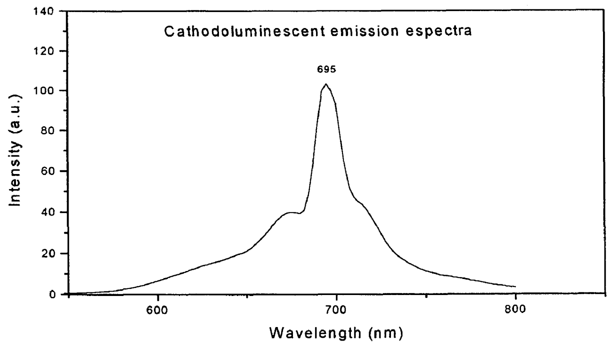

Figure 2. Intensity versus wavelength at 14 KV of acceleration voltage

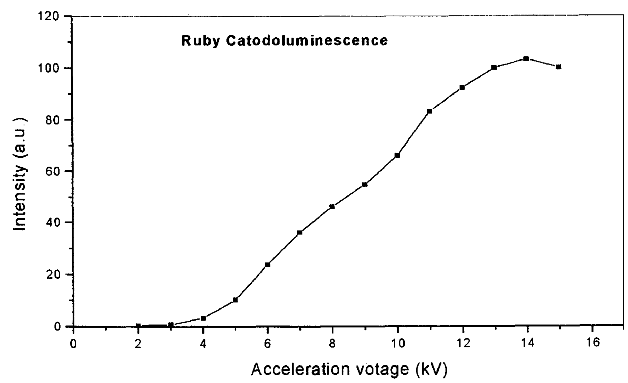

Figure 3 . Intensity versus Electron acceleration voltage

The lamp excitation spectra used for excite the samples is shown in Fig.4, in which it is observed two maximums at 265 and 365 nm, respectively. To obtain the emission spectra of the samples, we choose the 265 nm wave length due to its higher energy level. In Fig. 5 is shown the emission spectra that consist of one broad band centered at 697.5 nm. It is a red emission spectra. This transition correspond well with the cathodoluminescent peak emission spectra, so that, this is the same transition due to the chromium ion in the host lattice of the ruby

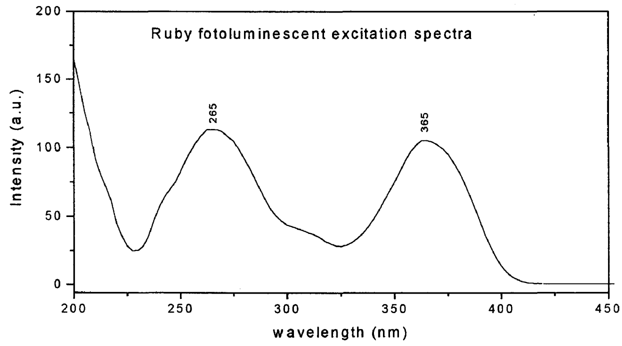

Figure 4. Excitation intensity versus wavelength

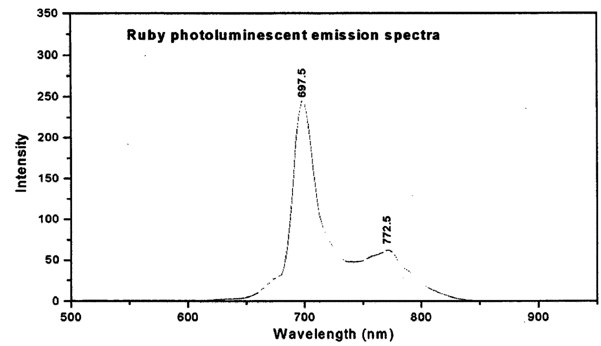

Figure 5. Emission spectra typical of ruby material

4 Conclusions

The emission spectra characteristics of ruby samples can be applied in red laser devices for communication systems, telemetric and optics devices.

References

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