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Temperature Dependence of Photoluminescence Intensity of Europium Dinuclear Complex

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Abstract : Quantum computation is a new and exciting field making use of quantum mechanical phenomena. In classical computers, information is represented as bits, with values either 0 or 1, but a quantum computer uses quantum bits in an arbitrary superposition of 0 and 1, enabling it to reach beyond the limits predicted by classical information theory. lanthanide ion quantum computer is an organic crystal, having a lanthanide ion. Europium is a favored lanthanide, since it exhibits nuclear spin coherence times, and Eu(III) is photo-stable and has two stable isotopes. In a europium organic crystal, the key factor is the mutual dipole-dipole interaction between two europium atoms. Crystals of the complex were formed by making a 2 :1 reaction of Eu(fod)3 and bpm. The transparent white crystals formed showed brilliant red luminescence with a 405 nm laser. The photoluminescence spectroscopy was observed both at room and cryogenic temperatures (300-14 K). The luminescence spectrum of [Eu(fod)3(μ-bpm) Eu(fod)3] showed characteristic of Eu(III) emission transitions in the range 570–630 nm, due to the deactivation of 5D0 emissive state to 7Fj. For the application of dinuclear Eu3+ complex to q-bit device, attention was focused on 5D0 -7F0 transition, around 580 nm. The presence of 5D0 -7F0 transition at room temperature revealed that at least one europium symmetry had no inversion center. Since the line was unsplit by the crystal field effect, any multiplicity observed was due to a multiplicity of Eu3+ sites. For q-bit element, more narrow line width of 5D0 → 7F0 PL band in Eu3+ ion was preferable. Cryogenic temperatures (300 K – 14 K) was applicable to reduce inhomogeneous broadening and distinguish between ions. A CCD image sensor was used for low temperature Photoluminescence measurement, and a far better resolved luminescent spectrum was gotten by cooling the complex at 14 K. A red shift by 15 cm-1 in the 5D0 - 7F0 peak position was observed upon cooling, the line shifted towards lower wavenumber. An emission spectrum at the 5D0 - 7F0 transition region was obtained to verify the line width. At this temperature, a peak with magnitude three times that at room temperature was observed. The temperature change of the 5D0 state of Eu(fod)3(μ-bpm)Eu(fod)3 showed a strong dependence in the vicinity of 60 K to 100 K. Thermal quenching was observed at higher temperatures than 100 K, at which point it began to decrease slowly with increasing temperature. The temperature quenching effect of Eu3+ with increase temperature was caused by energy migration. 100 K was the appropriate temperature for the observation of the 5D0 - 7F0 emission peak. Europium dinuclear complex bridged by bpm was successfully prepared and monitored at cryogenic temperatures. At 100 K the Eu3+-dope complex has a good thermal stability and this temperature is appropriate for the observation of the 5D0 - 7F0 emission peak. Sintering the sample above 600o C could also be a method to consider but the Eu3+ ion can be reduced to Eu2+, reasons why cryogenic temperature measurement is preferably over other methods.

Keywords : $Eu(fod)_3$, europium dinuclear complex, europium ion, quantum bit, quantum computer, 2,2-bipyrimidine
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