\[ \text{Gd}^{3+} \rightleftharpoons \text{Yb}^{3+} + \text{Tm}^{3+} + \text{Gd}^{3+} \]

\[ \text{Yb}^{3+} - \text{Tm}^{3+} - \text{Gd}^{3+} \]

引言

稀土掺杂上转换发光材料在固体激光器、彩色显示、环境探测等方面具有重要价值。然而，目前上转换激光研究者们追求的目标——达到百毫瓦量级的紫外及紫色上转换激光器是上转换激光材料科学领域最大的障碍。其中，紫色及紫外上转换激光器的主体激光泵浦是紫色及紫外上转换激光器是上转换激光研究者们追求的目标。紫激光输出能级的转移，通过敏化合作上转换把能量传递给Gd^{3+}、Yb^{3+}、Tm^{3+}和Ga^{3+}等。如表1所示，通过敏化合作上转换把能量传递给Gd^{3+}、Yb^{3+}、Tm^{3+}和Ga^{3+}等。

表1：Gd^{3+}、Yb^{3+}和Tm^{3+}的上转换发光性质研究

<table>
<thead>
<tr>
<th>负载功率</th>
<th>输出能级</th>
<th>激发功率</th>
<th>转移线路</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8-2 μJ</td>
<td>546 nm</td>
<td>980 nm</td>
<td>Y_{0.005}F_{3}：Gd^{3+}+Yb^{3+}+Tm^{3+}</td>
</tr>
<tr>
<td>0.8-2 μJ</td>
<td>522 nm</td>
<td>980 nm</td>
<td>Y_{0.005}F_{3}：Gd^{3+}+Yb^{3+}+Tm^{3+}</td>
</tr>
<tr>
<td>0.8-2 μJ</td>
<td>450 nm</td>
<td>980 nm</td>
<td>Y_{0.005}F_{3}：Gd^{3+}+Yb^{3+}+Tm^{3+}</td>
</tr>
</tbody>
</table>

1.1 对于Gd^{3+}、Yb^{3+}和Tm^{3+}的上转换发光性质研究

Gharavi等人通过研究发现，当负载功率为0.8-2 μJ时，输出能级为546 nm，522 nm和450 nm时，Y_{0.005}F_{3}：Gd^{3+}+Yb^{3+}+Tm^{3+}的上转换发光性质

实验

本文通过实时光谱和X射线衍射谱仪获得所用原料均为分析纯的\( \text{Y}_{2} \text{O}_{3} \)、\( \text{Yb}_{2} \text{O}_{3} \)、\( \text{Tm}_{2} \text{O}_{3} \)、\( \text{Gd}_{2} \text{O}_{3} \)和\( \text{Ga}_{2} \text{O}_{3} \)之间的相图。

2.1 对于Y_{0.8}F_{3}：Gd^{3+}+Yb^{3+}+Tm^{3+}的上转换发光性质研究

2.2 对于X射线衍射谱仪获得所用原料均为分析纯的\( \text{Y}_{2} \text{O}_{3} \)、\( \text{Yb}_{2} \text{O}_{3} \)、\( \text{Tm}_{2} \text{O}_{3} \)、\( \text{Gd}_{2} \text{O}_{3} \)和\( \text{Ga}_{2} \text{O}_{3} \)之间的相图。
null
The upconversion UV emission phenomenon is a unique property of nanocrystal materials. The emission enhancement phenomenon occurs in the material.

The normalized logarithm intensity normalized to $c_1/c_2/c_3/c_4/c_5/c_6/c_7/c_8/c_9$ is shown as a solid line in the fitting results by $f(t)=exp(-t/\tau)+exp(-t/\tau')$.

Fig. 3 Luminescence decay curves of both $Y_0.98F_1; Gd_0.20\%Yb_0.02\%Tm_{0.005}$ and $Y_0.98F_1; Gd_0.20\%Yb_0.02\%Tm_{0.005}$ samples (a) and (e).

Fig. 4 Energy-level scheme of $Yb^{3+}$ and $Tm^{3+}$ and processes of a few suggested UC transitions.
1. Processes of UC transitions and emissions.

2. Overall, processes of UC transitions and emissions.

3. The overall processes of UC transitions and emissions.

4. The overall processes of UC transitions and emissions.

5. The overall processes of UC transitions and emissions.

6. The overall processes of UC transitions and emissions.

7. The overall processes of UC transitions and emissions.


14. Xu Wenwei, Xu Xiaodong, Wu Feng et al. Infrared to visible upconversion fluorescence in Yb\(^{3+}\) Tm\(^{3+}\) YAG single crystal nanorods. Optics Communications 2007, 272(1), 182-185.


Energy Transition Processes between Yb$^{3+}$–Tm$^{3+}$–Gd$^{3+}$ in Gd$^{3+}$ $\square$ Yb$^{3+}$ and Tm$^{3+}$ Co–doped Fluoride Nanocrystal

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Abstract: Y$_{0.8-x-y}$F$_3$: Gd$^{3+}_{0.200}$ $\square$ Yb$^{3+}_{0.200}$ $\square$ Tm$^{3+}_{0.005}$ nanocrystals were synthesized through a hydrothermal method. The upconversion (UC) emission properties under a 980 nm continuous wave semiconductor laser diode excitation were studied. The experimental results suggested that the violet and ultraviolet (UV) UC emission enhancement were observed in Y$_{0.595}$F$_3$: Gd$^{3+}_{0.200}$ $\square$ Yb$^{3+}_{0.200}$ $\square$ Tm$^{3+}_{0.005}$ nanocrystal as well as the UC emissions of Gd$^{3+}$ of $^6D_{0/2} \rightarrow ^7I_{J}$ ($^7I_J$ ($Gd^{3+}$)) and $^6P_{7/2}$ states to the ground state $^8S_{7/2}$ were shown. The luminescent kinetic analysis implied that under 980 nm excitation Yb$^{3+}$ can transfer energy to populate the $^3P_2$ level of Tm$^{3+}$ make UV violet and blue UC emissions obtained further the $^7I_J$ multiplets of Gd$^{3+}$ were populated through the energy transfer process $^3P_2 \rightarrow ^3H_6$ (Tm$^{3+}$): $^8S_{7/2} \rightarrow ^6I_J$ (Gd$^{3+}$). At the same time the energy transfer processes occurred between Gd$^{3+}$ and Yb$^{3+}$ or Tm$^{3+}$ based on the energy matching conditions leading to the above mentioned UV UC emissions of Gd$^{3+}$.

Key words: rare earth; fluoride; nanocrystal; up-conversion emission

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