Analysis of radiative and non-radiative processes in oxide phosphors by simultaneous measurement of photoluminescence and photoacoustic signals

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Luminescence due to radiative transitions and heat due to nonradiative transitions occur after the light is absorbed by either the luminescent center or the host lattice in phosphors. To develop phosphors with high luminous efficiency, it is very important to suppress nonradiative processes. Consequently, it is necessary to obtain accurate information due to the nonradiative processes. In this study, the information about the heat value, which was generated in $Y_3Al_5O_{12}$:Ce (YAG:Ce) phosphors prepared with various Ce concentration, was obtained by measuring the photoacoustic (PA) signals. Fig. 1 shows the schematic diagram of the measurement system used in this study. This system was possible to measure simultaneously the PA and photoluminescence (PL) characteristics; the excitation wavelength was in the range from 250 to 600 nm. Both PL and PA signals were obtained from the all YAG:Ce phosphors when excited by a 460 nm blue light. It was found that the intensity of these signals was significantly affected by the Ce concentration. However, the Ce concentration dependences of PA and PL were complementary, as shown in Fig. 2. This result suggests that the decrease of PA intensity causes the increase of PL intensity. Thus, it is possible to develop new phosphors with high luminous efficiency by minimizing the PA signal after light excitation.

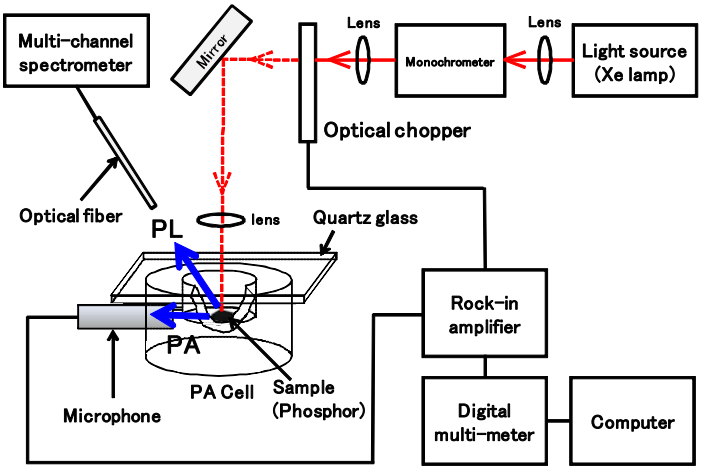

Fig. 1 Schematic diagram: apparatus for measuring simultaneously the PL and PA characteristics.

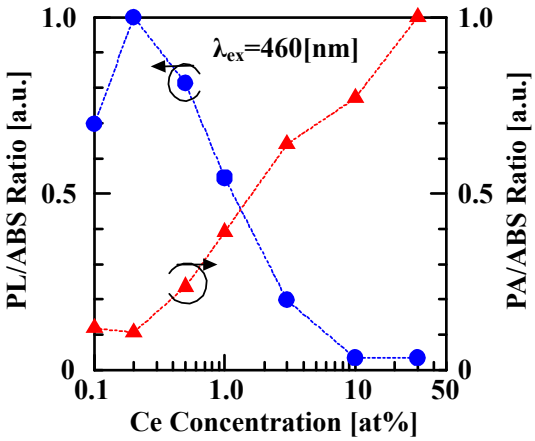

Fig. 2 PL and PA intensities as functions of Ce concentration in YAG:Ce phosphors.

光音響・フォトルミネッセンス同時測定法は、同一励起条件下における蛍光体の発光と非発光過程を同時に可視化することができる画期的な手法である。本手法を用いて蛍光体からの光音響信号を測定して、非発光過程の起源を特定し、さらにこの過程を最小化することにより、新しい高発光効率な蛍光体材料を早期に開発できるのではないかと考えている。