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# Bright Thermal (Blackbody) Emission of Visible Light From LnO2 (Ln = Pr, Tb), Photoinduced by NIR 980 nm Laser

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## Equipment descriptions

Powder X-ray diffraction was measured at Bruker D8 Advanced X-ray Diffractometer operating under CuKα radiation (40 kV, 40 mA) equipped with a LynxEye detector. The diffraction pattern was collected in the 2θ range of 10-70° with a step size of 0.02° and a count time of 1 s per step.
Thermogravimetry–differential thermal analysis (TG–DTA) curves were acquired through a SHIMADZU DTG-60H instrument in the range from 30˚C to 1000˚C using a platinum crucible, under dynamic synthetic air atmosphere (100 $ml.min^{-1}$) and with a heating rate of 10° $C.min^{-1}$.
The diffuse reflection spectra were obtained through a UV–visible recording spectrophotometer (SHIMADZU, UV-2600, Co., Japan), using $BaSO_4$ as reference and the optical absorptions were converted from the reflection spectra according to Kubelka-Munk equation.
The photoluminescence properties were performed in a spectrofluorimeter Horiba-Jobin Yvon Fluorolog-3 with double-grating monochromator in the UV-VIS (ultraviolet-visible) emission position, R928P Hamamatsu photomultipliers. All emission spectra were corrected by typical correction spectra provided by the manufacturer. The excitation was performed by coupling a 980 nm continuous diode laser from DMC LTDA. The optical fiber used is a UV/SR fiber from Ocean Optics, with core diameter of 600 μm and length of 1 m. The morphologic structure of oxides was performed using a scanning electron microscopy (SEM) microscope TESCAN MIRA 3 operateing at 10 kV. The dynamic light scattering (DLS) analysis were performed from an ethanolic suspension of REOs in a NanoBrook Omni equipment. The temperature of the samples during IR laser excitation was recorded with an IR thermal camera (FLIR T450sc). This camera is equipped with an uncooled Vanadioum Oxide (VoX) microbolometer detector that produces thermal images of 320 x 240 Pixels. Thermal Sensitivity of <0.03°C (30mK). All the measurements were performed at room temperature.

**Table S1.** Estimated black body temperature from the emission spectra of $PrO_2$, $Pr_6O_{11}$, $TbO_2$ and $Tb_4O_7$ irradiated with 980 nm CW laser at power density varying from 50 to 160 W $cm^{-2}$.

| Material | Power density (W $cm^{-2}$) | Temperature (K) |
|---|---|---|
| $PrO_2$ | 50 | 487 |
| | 60 | 648 |
| | 70 | 875 |
| | 80 | 1005 |
| | 90 | 1121 |
| | 100 | 1173 |
| | 110 | 1232 |
| | 120 | 1271 |
| | 130 | 1322 |
| | 140 | 1363 |
| | 150 | 1390 |
| | 160 | 1420 |
| $Pr_2O_{11}$ | 50 | 475 |
| | 60 | 589 |
| | 70 | 810 |
| | 80 | 1006 |
| | 90 | 1092 |
| | 100 | 1171 |
| | 110 | 1216 |
| | 120 | 1270 |
| | 130 | 1318 |
| | 140 | 1354 |
| | 150 | 1384 |
| | 160 | 1401 |
| $TbO_2$ | 50 | 462 |
| | 60 | 632 |
| | 70 | 819 |
| | 80 | 993 |
| | 90 | 1100 |
| | 100 | 1154 |
| | 110 | 1196 |
| | 120 | 1261 |
| | 130 | 1298 |
| | 140 | 1327 |
| | 150 | 1352 |
| | 160 | 1383 |
| $Tb_4O_7$ | 50 | 534 |
| | 60 | 738 |
| | 70 | 974 |
| | 80 | 1104 |
| | 90 | 1158 |
| | 100 | 1219 |
| | 110 | 1270 |
| | 120 | 1322 |
| | 130 | 1370 |
| | 140 | 1404 |
| | 150 | 1434 |
| | 160 | 1501 |

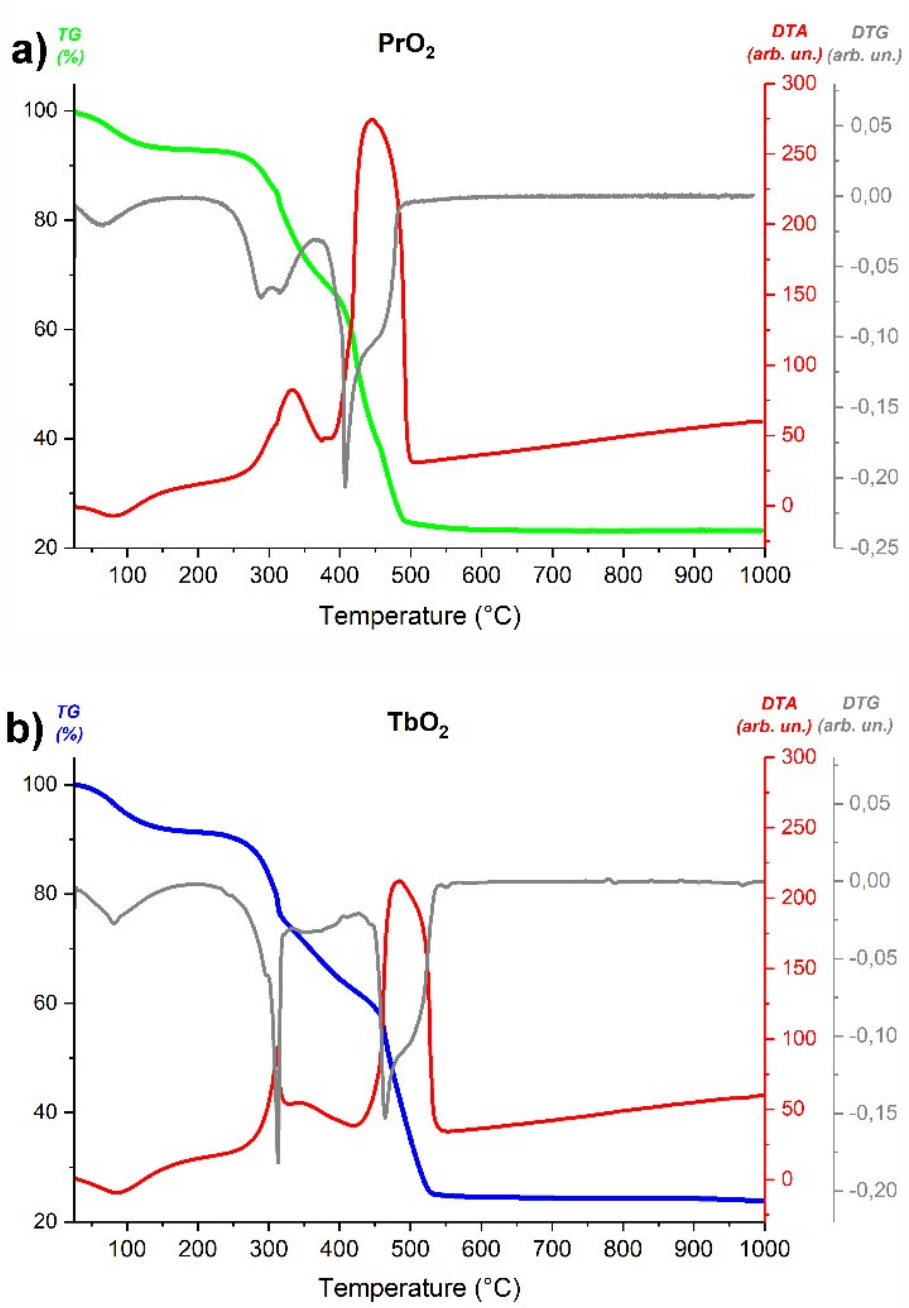


**Figure S1.** TG analysis (blue line), DTA (red line) and DTG (gray line) of precursors of the $TbO_2$ (a) and $PrO_2$ (b) treated at 300 °C.

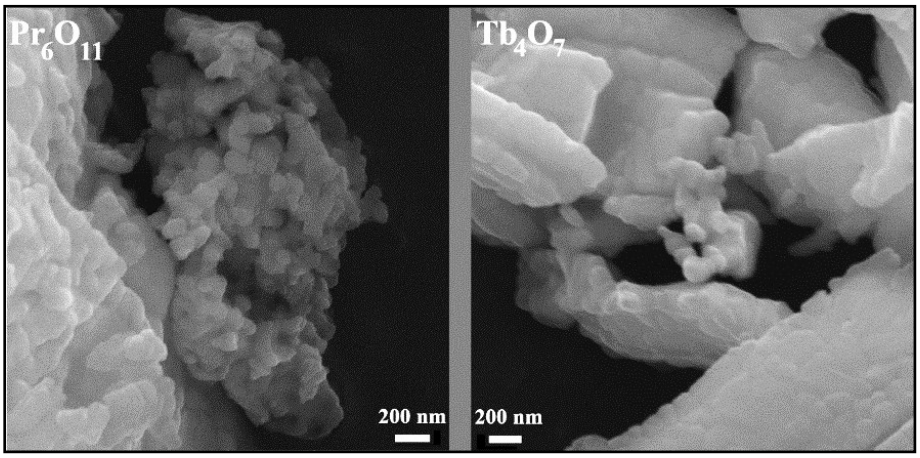


**Figure S2.** SEM images of the commercial $Pr_6O_{11}$ and $Tb_4O_7$ powders.

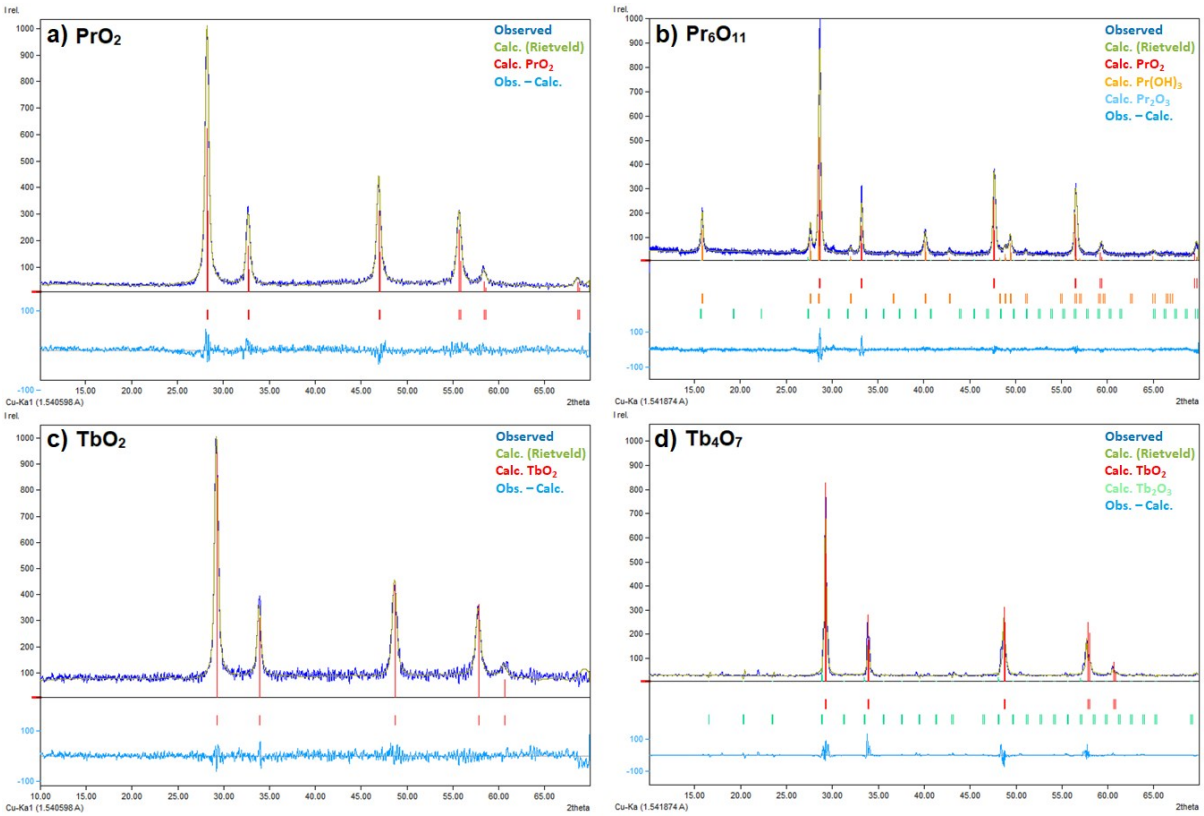


**Figure S3.** Rietveld refinement of the x-ray powder diffraction profiles $PrO_2$ (a), $Pr_6O_{11}$ (b), $TbO_2$ (c) and $Tb_4O_7$ (d). The expected reflection positions are displayed using vertical lines. Secondary phases of $Pr(OH)_3$ (33.7%), $Pr_2O_3$ (2.6%) (b) and $Tb_2O_3$ (5.6%) (d) were included in the refinement, and the contributions of the phases to the adjustment are plotted.

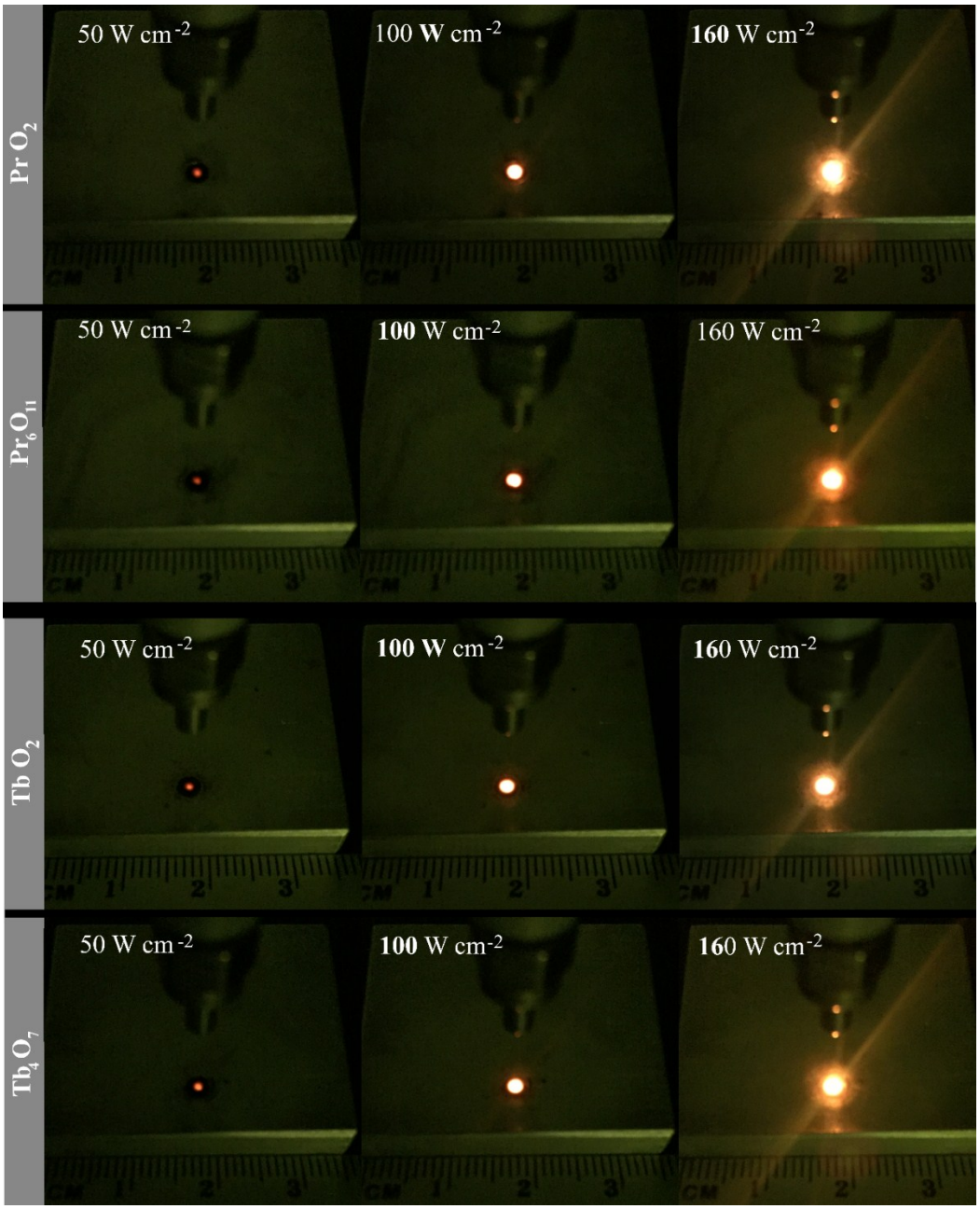


**Figure S4.** Photograph of the $PrO_2$, $Pr_6O_{11}$, $TbO_2$ and $Tb_4O_7$ under excitation with 980 nm CW laser at power density ranging from 50 to 160 W $cm^{-2}$.

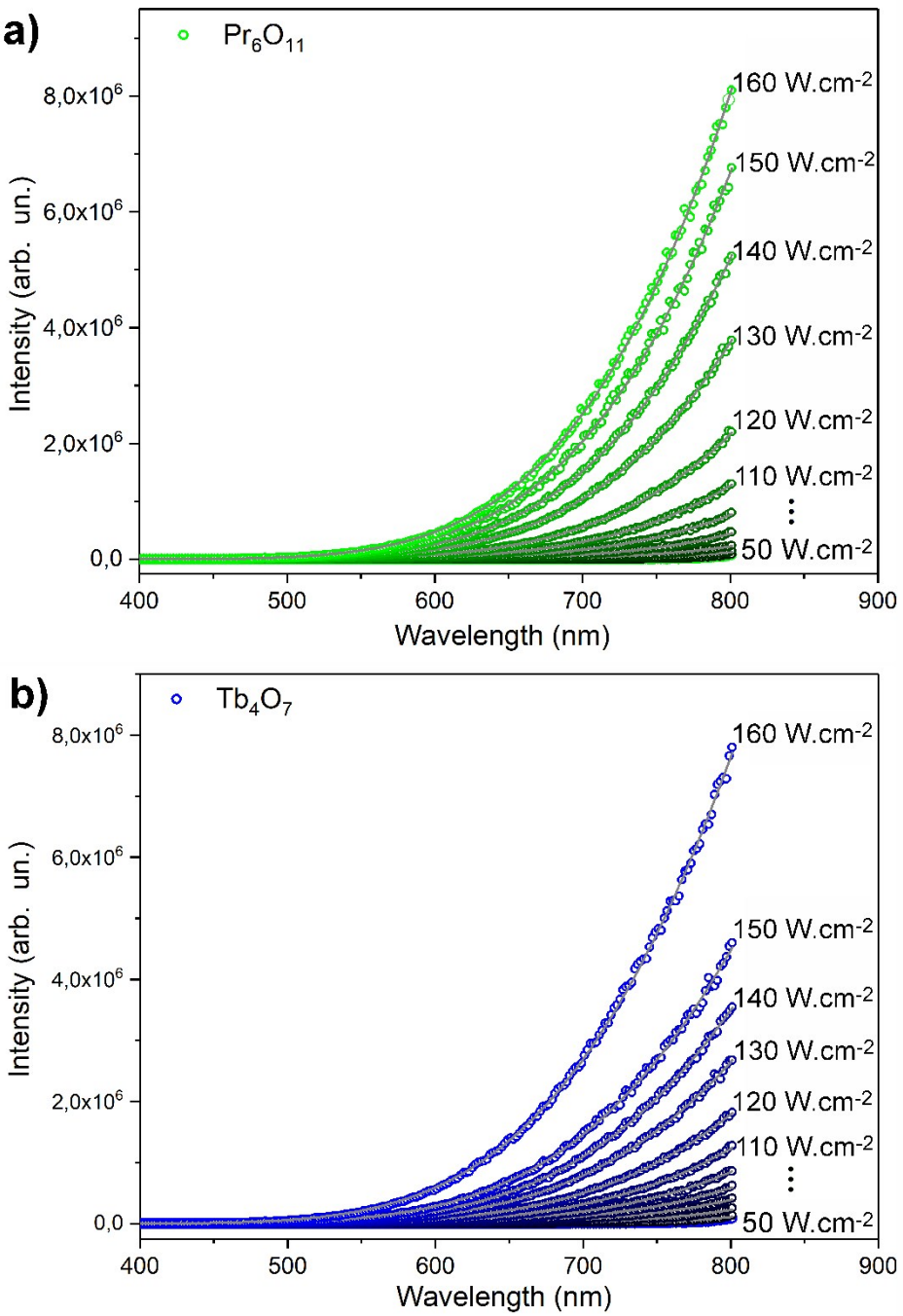


**Figure S5.** Photoinduced blackbody emission spectra of $Pr_6O_{11}$ (green circle in (a)) and $Tb_4O_7$ (blue circle in (d)) recorded under 980 CW laser excitation and adjusted power density from 50 to 160 $Wcm^{-2}$. Each spectrum was adjusted according to Planck's law (solid gray lines) to obtain the blackbody temperature.

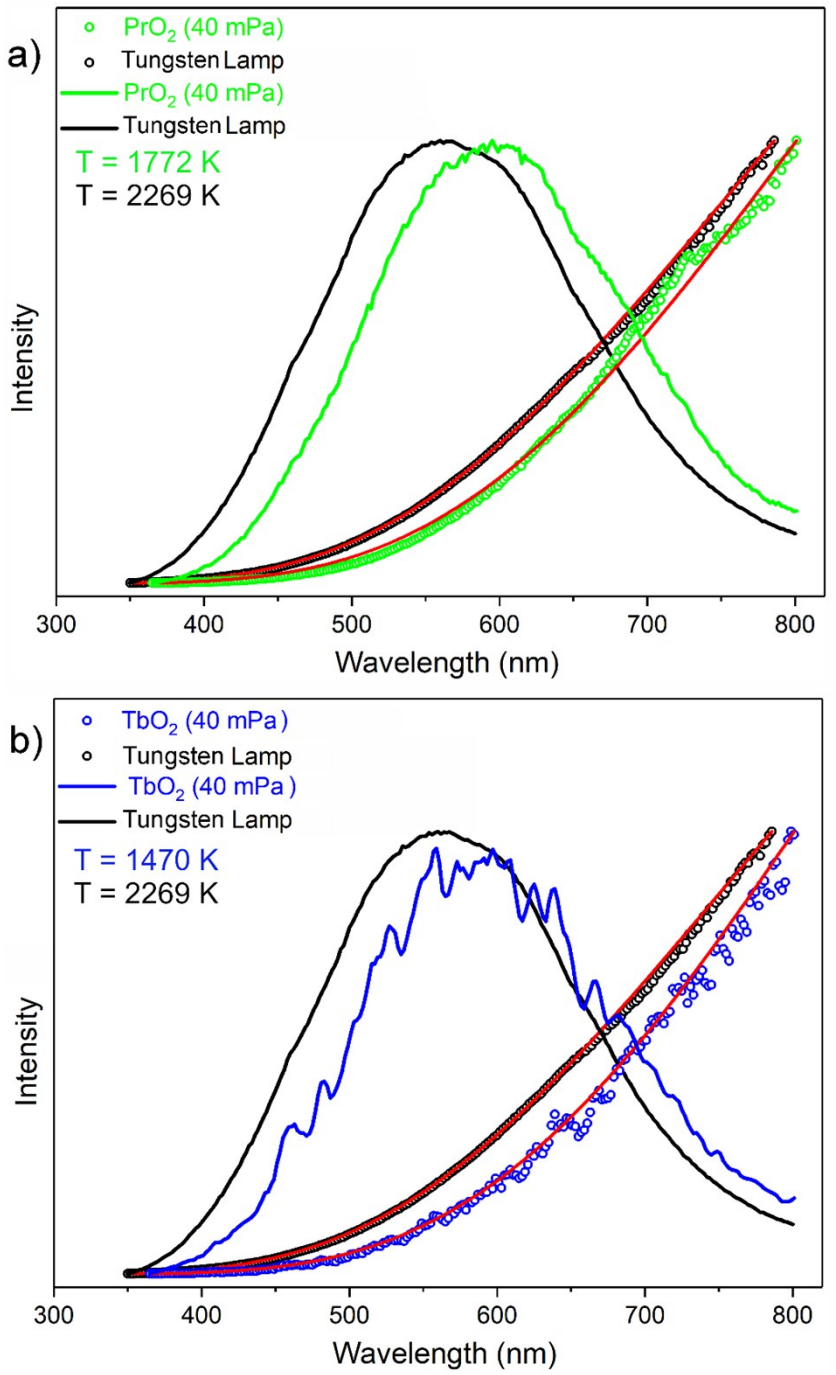


**Figure S6.** Corrected (symbol) and uncorrected (black, green and blues solid line) blackbody spectra of $PrO_2$ (a), $TbO_2$ (b) under vacuum recorded with a 980 CW laser excitation and tungsten lamp. The red lines are the planckian curves. The structure in the spectra of the $TbO_2$ is correlated to melting of the sample and their possible evaporation.

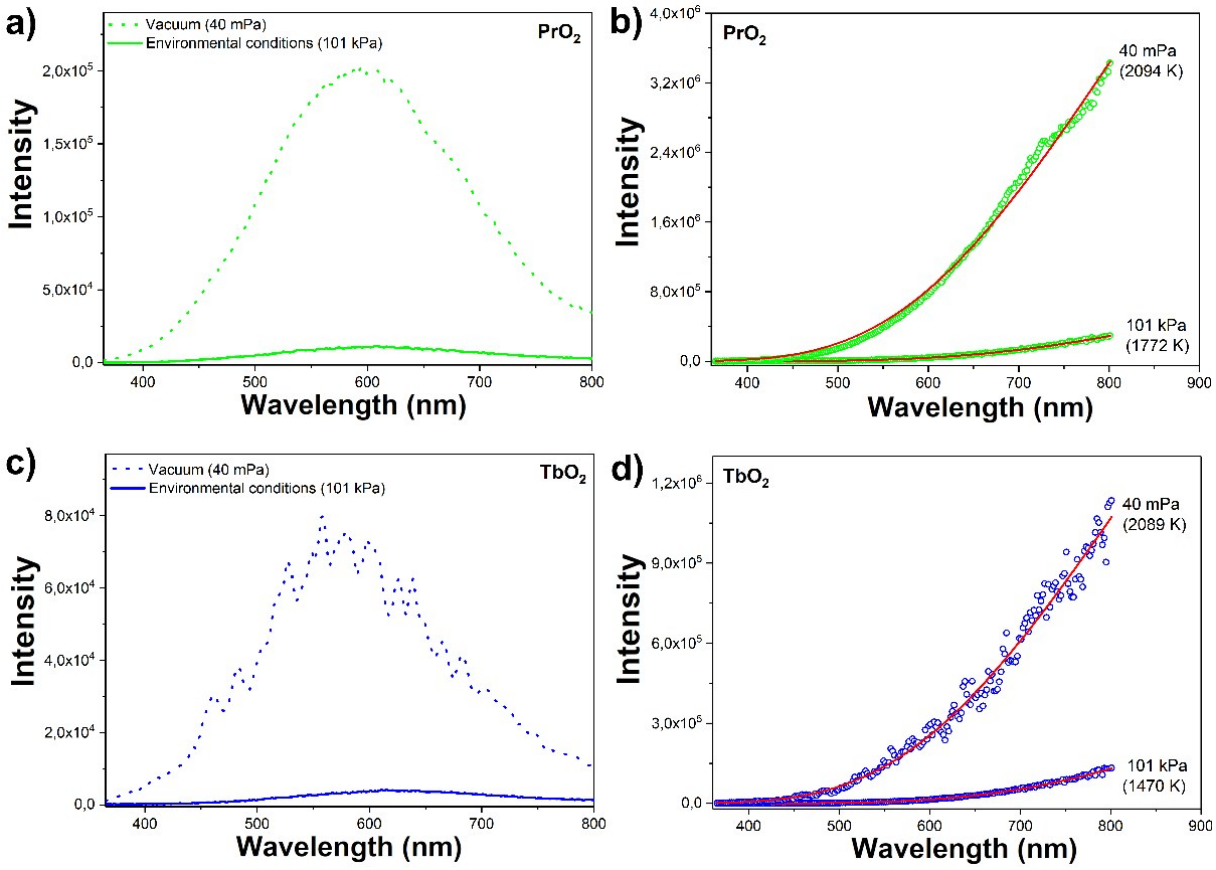


**Figure S7.** Corrected (b and d) and uncorrected (a and c) blackbody spectra of $PrO_2$, $TbO_2$ under vacuum (40 mPa) and atmospheric conditions. The red lines are the planckian curves. The structure in the spectra of the $TbO_2$ under vacuum is correlated to melting of the sample and their possible evaporation.

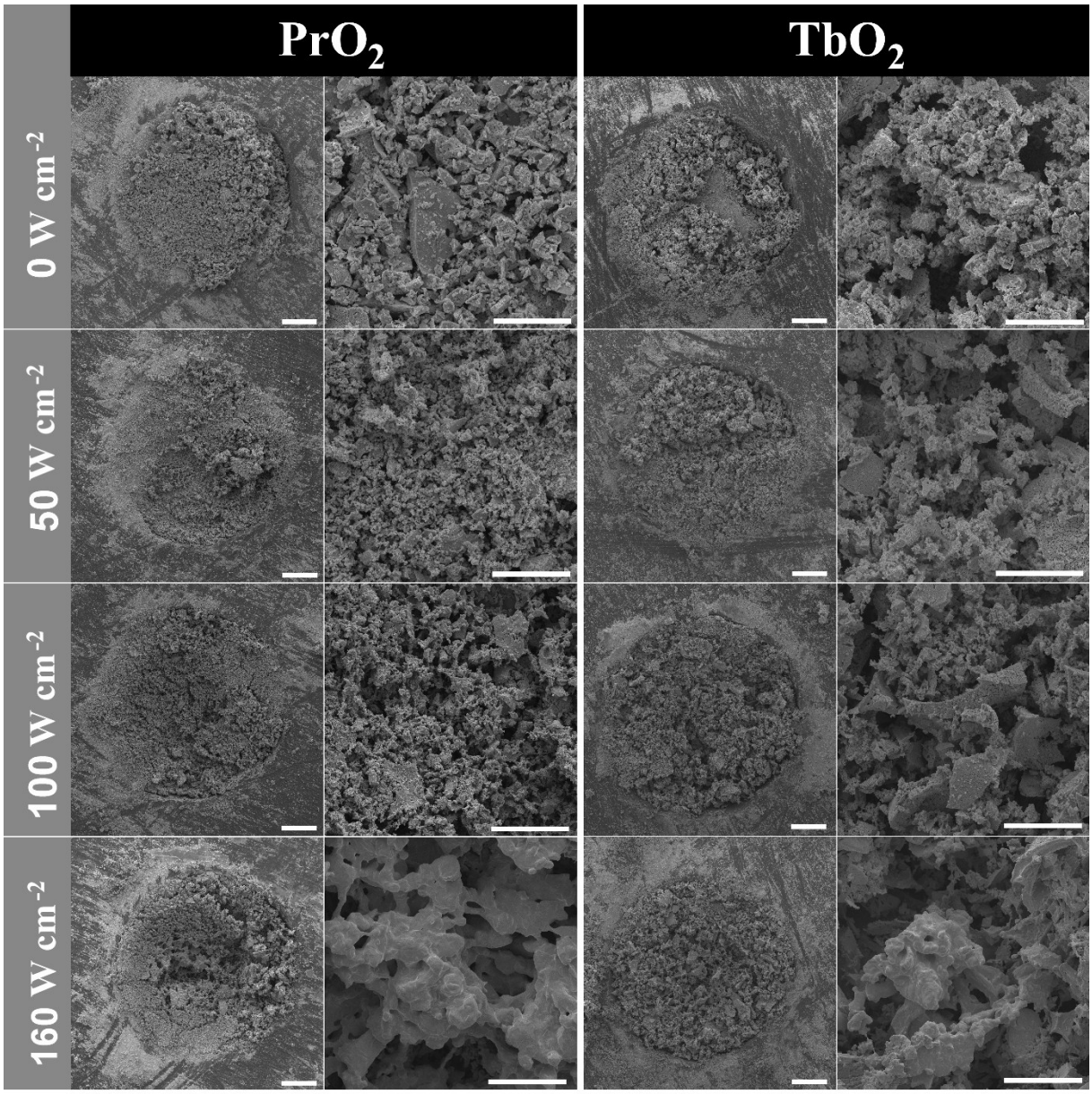


**Figure S8.** Micrographs of MEV of the synthesized $LnO_2$ after exposure to 980 laser beam with power density varying from 50 to 160 W $cm^{-2}$. The smaller scale bar correspond to 200 μm and the largest scale bar correspond to 50 μm.

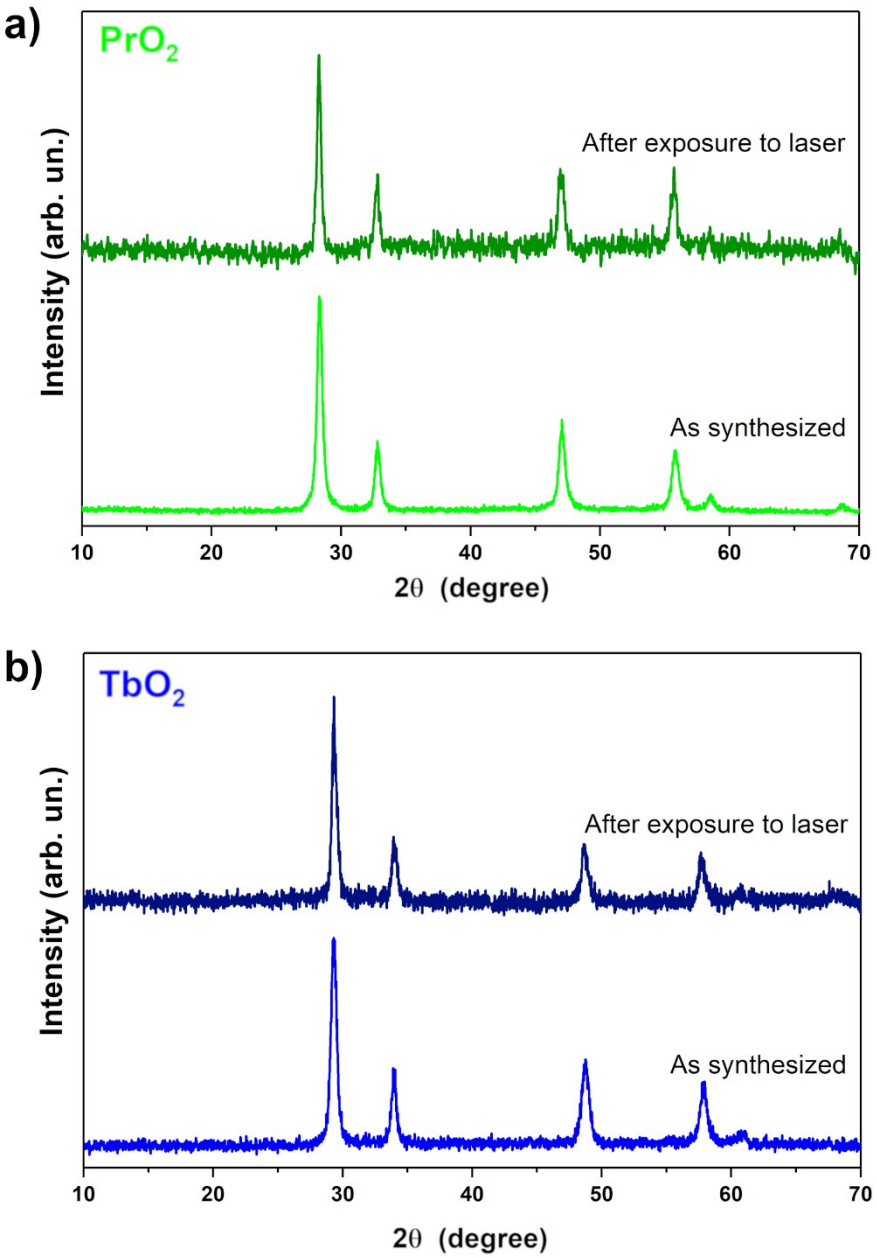


**Figure S9.** X-ray diffraction of $LnO_2$ powders as synthesized and after exposure to 980 CW laser with power density of 160 W $cm^{-2}$.

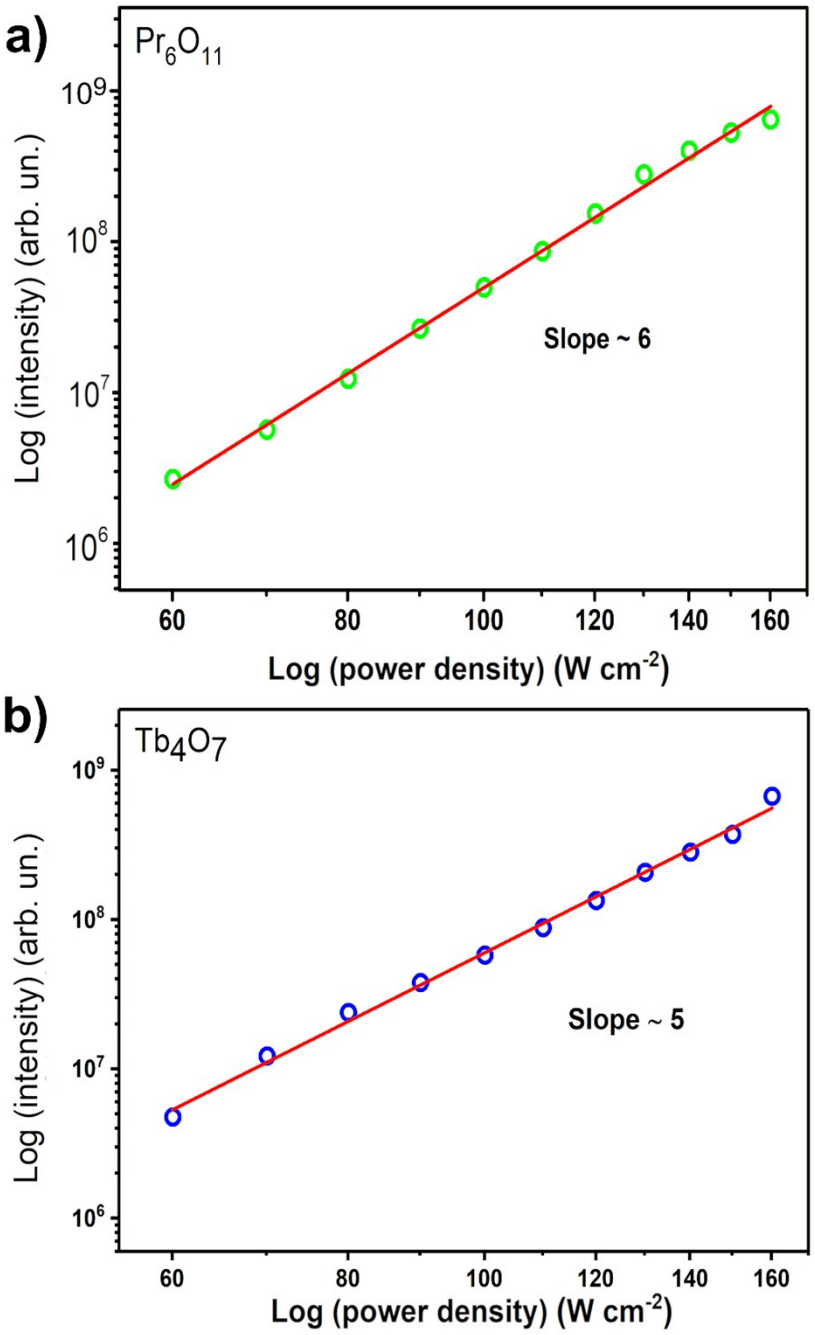


**Figure S10.** Double-log plots of pump power vs. integrated intensity of the photoinduced blackbody emission of $Pr_6O_{11}$ (a) and $Tb_4O_7$ (b) powders under atmospheric pressure.