Upconversion spectroscopy of $Al_2O_3:Er^{3+}$

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The excitation and relaxation processes relevant for establishing optical gain in $Al_2O_3:Er^{3+}$ on the $^4I_{13/2} \rightarrow {}^4I_{15/2}$ transition at 1.5 µm are investigated. Excited-state absorption in the wavelength range from 900-1800 nm is measured in a pump-probe experiment. The $^4I_{13/2}$ and $^4I_{11/2}$ lifetimes are measured after direct excitation and the macroscopic parameter of the energy-transfer-upconversion (ETU) process ($^4I_{13/2}$, $^4I_{13/2}$) $\rightarrow$ ($^4I_{15/2}$, $^4I_{9/2}$) is determined independently from both decay curves. By use of the Zubenko model the microscopic parameters of ETU and energy migration are derived. It is found that above the Er^{3+} concentration at which the transition from static to migration-accelerated ETU takes place also the 1.5-µm amplifier gain is diminished by this process.