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Blue up-conversion emission of $Nd^{3+}/Tm^{3+}/Yb^{3+}$ triply doped aluminophosphate optical fibers

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Glasses containing rare-earth ions (RE^{3+}) for up-conversion luminescence have been widely explored in several photonic applications. Materials containing Tm^{3+} present intense blue emission when excited in the near-infrared range, allowing them to be used as solid-state lasers and other emitter devices. Tm^{3+} are generally combined with other rare-earth ions to improve the up-conversion efficiency; however, increasing the number of dopants can be an issue for their solubility in the glass matrix and fiber drawing. In this work, aluminum-phosphate glasses, a host matrix with high rare-earth solubility and fiber-drawing ability, were produced containing different amounts of Tm^{3+}, Nd^{3+}, and Yb^{3+}, as well as the respective triply-doped optical fibers. Glass samples containing RE^{3+} were excited at 808 nm and 980 nm to evaluate the mechanism involved in the luminescence process. In addition, tri-doped optical fibers were excited at 788 and 980 nm, and bright blue luminescence was observed at both wavelengths. Thus, due to the intense up-conversion emission measured on RE^{3+} triply doped optical fibers with low optical loss, the developed material presents great potential for fiber-based photonic applications.