BaAlxOy:Eu2+,Dy3+ blue-green phosphor samples were synthesized by a combustion method at the low temperature of 500°C. Phosphor nanocrystallites with high brightness were obtained without significantly changing the crystalline structure of the host. The crystallite sizes determined from the Scherrer equation ranged between 34 and 41 nm. Different volume fractions of the BaAlxOy:Eu2+,Dy3+ powder were then introduced in LDPE polymer. The resulting composites were similarly analyzed and also thermally characterized by means of differential scanning calorimetry (DSC) and thermogravimetric analysis (TGA). PL results indicate that the LDPE-phosphor interface, which is considered to have an influence on the composite behavior, did not significantly change the spectral positions of the phosphor materials, whose major emission peaks occurred at about 505 nm. The improved afterglow results for the composites may have been caused by morphological changes due to increased surface area and defects. Thermal results indicate that the BaAlxOy:Eu2+,Dy3+ particles acted as nucleating centers and enhanced the overall crystallinity in the LDPE nanocomposite while preventing lamellar growth, hence reducing the crystallite sizes in LDPE. © 2011 Wiley Periodicals, Inc. J Appl Polym Sci, 2011