Advanced Sensors for Radiation Detection

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Gamma rays have highest frequency and possess high energy in the electromagnetic spectrum. Wide application of Gamma radiation sensors in nuclear facilities, medical dosimetry and space applications mandate sensors with strongly differing specifications, especially wide range of detection and capacity to detect low levels of radiation. This research project depicts development of novel radiation sensors using Radio-photoluminescence (RPL) properties of materials. Luminescence efficiency of materials, which has important role in defining the sensitivity of radiation sensor, was enhanced by doping suitable light sensitive molecules called fluorophores that support Resonance Energy Transfer (RET). Luminescence efficiency of KCl, a highly abundant material with low light yield properties, was enhanced using appropriate aliovalent impurity combinations. KCl pellets with different impurity combinations were synthesized and apparent changes in light output were investigated. KCl exhibited enhanced RPL with monovalent Ag^{+} doping. The intensity was further increased by 5% with Ce^{3+} co-doping whereas an enhancement of 8% was observed with trivalent-trivalent impurity co-doping (Eu^{3+},Ce^{3+}). Highest luminescence enhancement of 11% was observed for divalent-trivalent ion co-doping, (Mn^{2+},Ce^{3+}) in KCl lattice. The results showed that impurities supporting RET exhibited enhanced luminescence efficiency, which is substantiated using Photoluminescence studies. The dose response comparison of developed sensors demonstrated wider range of linear operation and capacity to detect lower radiation than the existing sensor, BaFBr:Eu^{2+}. This study showcase the use of RET in luminescence enhancement of low light yield materials, and sets the stage for future developments in this arena.