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FABRICATION OF A HIGH-PERFORMANCE AND STABLE RADIOLUMINESCENCE NUCLEAR BATTERY BASED ON BILAYER FILM OF ZERO DIMENSIONAL CORE-SHELL ZNCDSE-ZNS QDS AND CSPBBR3 PEROVSKITE QDS AS POTENTIAL POWER SOURCE FOR SPACE EQUIPMENTS

Abstract

Self-powered, lightweight, low-cost, reliable, durable and high performance space equipments are extremely important for exploring the outer planets. However, because of long unattended operation time and harsh space environment, a reliable, economical, robust and effective power source is required which can be used to operate the space equipments. Recently, the radioluminescence nuclear batteries (RNBs) (i.e. non-thermal atomic batteries) are considered as promising energy sources which effectively convert particle radiation energy to electricity because of its various characteristics such as high-energy density, extremely long life, and strong endurance under harsh conditions. The radioluminescence nuclear batteries are made using high luminescent materials because of their high quantum eciency and high stability in response to both photon and radiation energy. Recently, due to excellent electrical and optical properties, such as tunable band gap and good optical absorption, organolead halide perovskite materials have shown great performance in photovoltaic devices. Thus, perovskite materials are used to fabricate radioluminescence nuclear batteries which exhibited better efficiencies. However, even though these perovskites based radioluminescence nuclear batteries exhibited better overall efficiency, but there is still plenty of room to improve the efficiencies of such devices. Herein, we report the fabrication of a high-performance and stable radioluminescence nuclear battery based on bilayer film of zero dimensional core-shell ZnCdSe-ZnS/ CsPbBr3 QDs as potential power source for future space equipments. The fabrication of zero dimensional core-shell ZnCdSe-ZnS/ CsPbBr3 QDs was done to enhance the overall photoluminescence of hybrid film which was studied by several techniques such as steady-state photoluminescence (PL) and Time-Resolved Photoluminescence (TRPL). Interestingly, the fabricated hybrid film exhibited a higher photoluminescence compared with that of pure ZnCdSe/ZnS or CsPbBr3 QDs based films due to the efficient energy transfer from the ZnCdSe/ZnS QDs to Perovskite QDs, and reduced charge traps. The enhanced photoluminescence of the hybrid film resulted from excellent energy band alignment between core-shell ZnCdSe-ZnS QDs and all-inorganic CsPbBr3 perovskite QDs, which significantly improve the charge transfer rate. Furthermore, the hybrid film was incorporated with Si photovoltaic device to fabricate Radioluminescence nuclear batteries. Electrical measurements of these batteries were performed under different radiation sources which reveal significant improvement in the efficiency compared to pure ZnCdSe/ZnS or CsPbBr3 QDs based batteries. The findings observed clearly revealed that the proposed zero-dimensional core-shell ZnCdSe-ZnS/ CsPbBr3 QDs bilayer film can be used effectively as a possible high-performance luminescent martial and stable nuclear battery for space applications.