Low dose of X-ray-excited long-lasting luminescent concave nanocubes in highly passive targeting deep-seated hepatic tumors

Zheng-Zhe Chen¹, Liu-Chun Wang¹, Divinah Manoharan¹, Chin-Lai Lee², Lai-Chin Wu³, Wan-Ting Huang¹, Eng-Yen Huang⁴, Chia-Hao Su², Hwo-Shuenn Sheu³, Chen-Sheng Yeh¹,*

¹ Department of Chemistry, National Cheng Kung University
² Institute for Translational Research in Biomedicine, Kaohsiung Chang Gung Memorial Hospital
³ National Synchrotron Radiation Research Center
⁴ Department of Radiation Oncology, Kaohsiung Chang Gung Memorial Hospital

csyeh@mail.ncku.edu.tw

Advanced Materials, Volume 31, Issue 49

The recent development of the optical bioimaging techniques combined with nanoprobes has gradually gain the merits of high sensitivity, time effectiveness, harmless, deeper radiation, and spatial and temporal precision. Unfortunately, the in vivo imaging still faces two challenges: the poor signal-to-noise (S/N) because of the tissue autofluorescence and the limitation of the penetration depth in tissue under in situ external excitation. Considering the avoidance of the tissue autofluorescence interference, the long-lasting luminescence (LLL) or afterglow nanoparticles with the characteristic of the luminescence remaining after the excitation ceased are able to improve the S/N signal by removing the tissues background noise from in situ excitation. Usually, the lifetime would decay in nanoseconds for the biological luminescent signal. Therefore, the LLL could be collected when the short-lived biological background disappeared. The LLL nanoparticles are capable of storage of radiation where the trapped electrons and holes would slowly emit photons following the recombination of the electrons and holes.

Another endurance is the selection of the external excitation source to surmount the penetration limitation. Noticeable, the red light or even the NIR sources suffers from the limit of the tissue penetration. Consequently, X-ray is the best choice for imaging deeper tissue.

Taking together for the aforementioned concerns, i.e. elimination of tissue autofluorescence interference and escape of tissue penetration limit for in situ excitation, the nanoparticles showing LLL subjected to X-ray excitation seems to become a promising choice to meet both demands for in vivo imaging.

We have synthesized the ZnGa₂O₄:Cr³⁺ concaved nanocube, which, to the best of our knowledge, has not been reported before. This nanoprobes with the cubic morphology can emit a bright LLL using a low dose of 0.5 Gy at the end of X-ray excitation for the deep seated tissues.
X-ray excited afterglow luminescence

Copyright 2018 National Cheng Kung University