Photothermal therapy

Photothermal therapy refers to efforts to use electromagnetic radiation for the treatment of various medical conditions, including cancer. This approach is an extension of photodynamic therapy, in which a photosensitizer is excited with specific band light.

Zhang et al. developed a photothermal therapy (PTT) based on Molybdenum carbide nanosheets for melanoma treatment while utilizing integrated metabolomics to investigate the metabolic shift of metabolome combined lipidome during PTT at the molecular level. The results demonstrated that 1 mg ml-1 Mo2C nanosheets could efficiently convert laser energy into heat with a strong and stable photothermal effect (74 ± 0.9 °C within 7 cycles). Furthermore, Mo2C-based PTT led to a rapid decrease in melanoma volume (from 3.299 to 0 cm2) on the sixth day, indicating the effective elimination of melanoma. Subsequent integrated metabolomics analysis revealed significant changes in aqueous metabolites (including organic acids, amino acids, fatty acids, and amines) and lipid classes (including phospholipids, lysophospholipids, and sphingolipids), suggesting that melanoma caused substantial fluctuations in both metabolome and lipidome, while Mo2C-based PTT helped improve amino acid metabolism-related biological events (such as tryptophan metabolism) impaired by melanoma. These findings suggest that Mo2C nanosheets hold significant potential as an effective therapeutic agent for skin tumors, such as melanoma. Moreover, through exploring multidimensional bioinformation, integrated metabolomics technology provides novel insights for studying the metabolic effects of tumors, monitoring the correction of metabolic abnormalities by Mo2C nanosheet therapy, and evaluating the therapeutic effect on tumors [1)].

The second near-infrared (NIR II) type I photosensitizer has the intrinsic advantages in photodynamic therapy/photothermal therapy (PDT/PTT) of some malignant tumors (MTs) with deep infiltration, large size, complicated location, and low possibility of surgery/radiotherapy. Herein, three chalcogen-elements-based donor-acceptor (D-A) type semiconducting polymers (PTS, PTSe, and PTTe) have been synthesized and fully characterized, demonstrating strong absorption in near infrared (NIR) II region. Upon adjusting the chalcogen elements, the intramolecular charge transfer (ICT) characteristics and the heavy atom effect are tuned to enhance the intersystem crossing rate, improving the photodynamic effect. Moreover, the energy levels and Gibbs free energies are tuned to facilitate the type I photodynamic process. As a result, PTTe NPs produce superoxide anion radicals ($O_2^{\bullet-}$) more efficiently and demonstrate higher photothermal conversion efficiency than PTS and PTSe NPs upon a NIR II (1064 nm) laser irradiation, exhibiting unprecedented NIR-II type I PDT/PTT performance in vitro and in vivo. This work provides ideas for achieving high performance NIR-II type I PDT/PTT SPs for hypoxic oncotherapy [2)].

1)
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2)
Wen K, Tan H, Peng Q, Chen H, Ma H, Wang L, Peng A, Shi Q, Cai X, Huang H. Achieving Efficient NIR-II Type I Photosensitizers for Photodynamic/Photothermal Therapy upon Regulating Chalcogen

Elements. Adv Mater. 2021 Dec 21:e2108146. doi: 10.1002/adma.202108146. Epub ahead of print. PMID: 34935224.