14th International Conference on

Plasma Based Ion Implantation & Deposition

PBII&D 2017

New World Shanghai Hotel

October 17-20, 2017, Shanghai, China

Program

Organized by

Shanghai Institute of Ceramics, Chinese Academy of Sciences (SIC CAS)
Shanghai Institute of Microsystem and Information Technology, Chinese Academy of Sciences (SIMIT CAS)

14th PBII&D Committees

Organizer

Shanghai Institute of Ceramics, Chinese Academy of Sciences
Shanghai Institute of Microsystem and Information Technology, Chinese Academy of Sciences

International Organizing Committee

P. K. Chu (Chairman)	Hongkong, China
M. Bilek	Australia
N. Huang	China
S. Mändl	Germany
A. Márquez	Argentina
L. Pichon	France
X. B. Tian	China
M. Ueda	Brazil
R. H. Wei	USA

Local Organizing Committee

Xuanyong Liu (Chair)	Shanghai Institute of Ceramics, CAS
Zengfeng Di (Co-Chair)	Shanghai Institute of Microsystems and Information Technology, CAS
Yongfeng Mei	Fudan University
Zhenghua An	Fudan University
Zhongying Xue	Shanghai Institute of Microsystems and Information Technology, CAS
Huiliang Cao	Shanghai Institute of Ceramics, CAS

ID 86

Cell-borne 2D nanomaterials for efficient cancer targeting and photothermal therapy

Zhibin Li [1, 2], Jundong Shao [1], Qian Luo [1], Xue-Feng Yu [1, *], Hanhan Xie [1], Haidi Fu [3], Siying Tang [1], Huaiyu Wang [1, *], Guangli Han [3], Paul K. Chu [2, *]

[1] Institute of Biomedicine and Biotechnology,
Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences,
Shenzhen 518055, Guangdong, P. R. China
[2] Department of Physics and Materials Science, City University of Hong Kong,
Tat Chee Avenue, Kowloon, Hong Kong, China
[3] School and Hospital of Stomatology, Wuhan University,
237 Luoyu Road, Wuhan 430079, P. R. China

Keywords: 2D nanomaterials, Bi_2Se_3 nanosheets, near-infrared, drug delivery, photothermal therapy

Introduction: Two of the challenges for clinical implementation of nano-therapeutic strategies are optimization of tumor targeting and clearance of the nanoagents *in vivo*. Herein, a cell-mediated therapy by transporting 2D Bi_2Se_3 nanosheets within macrophage vehicles is described. The Bi_2Se_3 nanosheets with excellent near-infrared photothermal performance exhibit high macrophage uptake and negligible cytotoxicity thus facilitating the fabrication of Bi_2Se_3-laden-macrophages. Compared with bare Bi_2Se_3, the Bi_2Se_3-laden-macrophages after intravenous injection show prolonged blood circulation and can overcome the hypoxia-associated drug delivery barrier to target the tumor efficiently and dramatically enhance the efficiency of photothermal cancer therapy. The Bi_2Se_3-laden-macrophages possess good biocompatibility as demonstrated by the biochemical and histological analyses and furthermore, most of the materials are excreted from the body within 25 days. Our findings reveal a desirable system for highly efficient near-infrared photothermal cancer therapy.

Materials and Methods: Bi_2Se_3 nanosheets were prepared and characterized according to the method described previously [1]. The macrophages uptake of Bi_2Se_3 nanosheets is analyzed by ICP-OES. The Bi_2Se_3-laden-macrophages *in vivo* photothermal cancer therapy were injected *via* the tail vein and irradiated (808 nm, 1.0 W/cm^2) 10 min.

Results and Discussion: As shown in Fig. 1, the Bi_2Se_3 nanosheets exhibit negligible cytotoxicity and high macrophage uptake efficiency. The good biocompatibility of Bi_2Se_3 nanosheets is probably because Bi is an environmentally friendly element and Se is an essential trace element [2]. *In vivo* photothermal cancer therapy results demonstrate that Bi_2Se_3-laden-macrophages are efficient agents in photothermal ablation of tumors (Figure. 2).

Conclusion: Bi_2Se_3-laden-macrophages constitute an efficient delivery system in photothermal cancer therapy. The strategy utilizes macrophages as “Trojan horses” carrying 2D Bi_2Se_3 nanosheets with high NIR photothermal performance, high macrophage uptake, and negligible cytotoxicity. The Bi_2Se_3-laden-macrophages constitute a highly efficient PTT system by optimizing the *in vivo* agent delivery and photothermal efficiency and this cell-mediated strategy can be further extended to other nanomaterials or drug-based therapies.

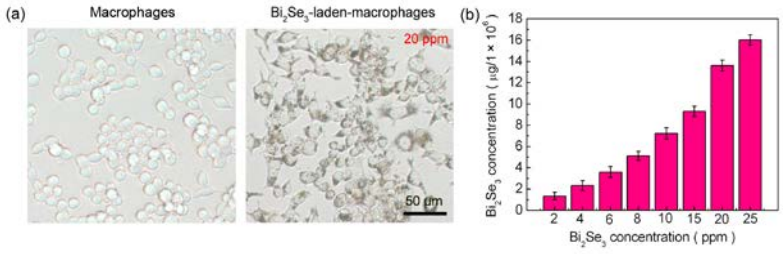

Figure 1. Macrophages uptake of Bi_2Se_3 nanosheets: (a) Bright-field images of macrophages before and after uptake of Bi_2Se_3 nanosheets; (b) Quantitative determination of macrophages uptake of Bi_2Se_3 nanosheets.

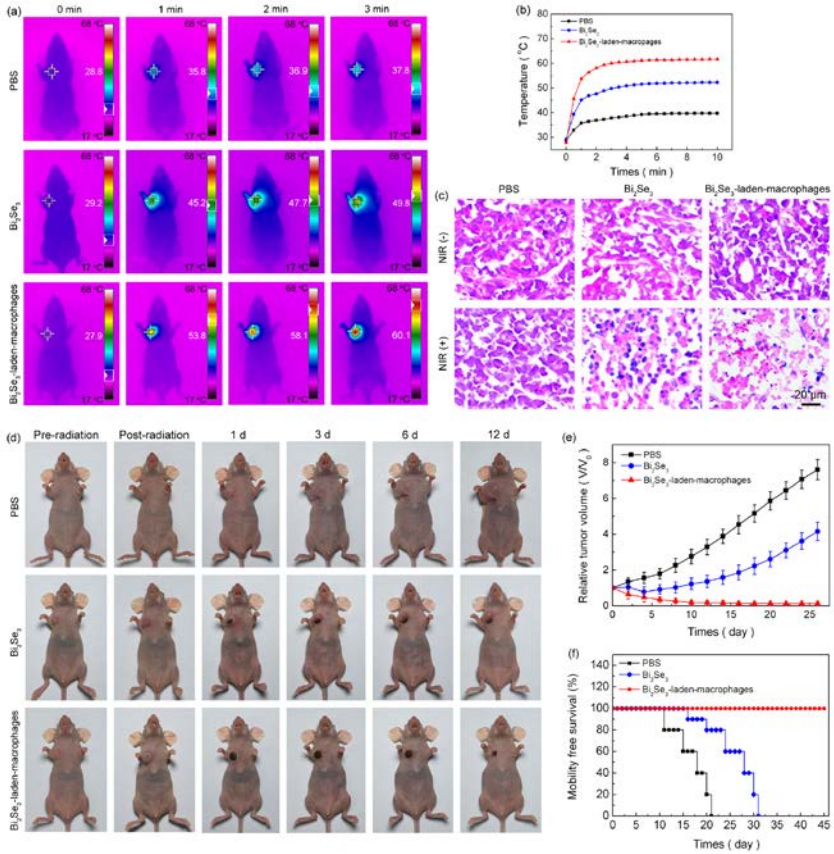

Figure 2. *In vivo* photothermal cancer therapy of BALB/c nude mice bearing MCF-7 breast tumors under 10 min of NIR irradiation (808 nm, 1.0 W/cm^2) at 24 h post-injection of PBS, Bi_2Se_3 nanosheets, and Bi_2Se_3-laden-macrophages intravenously: (a) IR thermal images of the mice; (b) Curves of tumor temperature versus time; (c) H&E staining of tumor sections; (d) Typical mice before and after PTT treatments for 0, 1, 3, 6, and 12 days; (e) Tumor growth curves of different groups of mice; (f) Survival curves of different groups of mice.

References:

[1] Y. Min, G.D. Moon, B.S. Kim, B. Lim, J.S. Kim, C.Y. Kang, et al., Quick, controlled synthesis of ultrathin Bi_2Se_3 nanodiscs and nanosheets, J. Am. Chem. Soc. 134 (2012) 2872-2875.

[2] J. Li, F. Jiang, B. Yang, X.R. Song, Y. Liu, H.H. Yang, et al., Topological insulator bismuth selenide as a theranostic platform for simultaneous cancer imaging and therapy, Sci Rep. 3 (2013) 1998.

Corresponding:

Email: xf.yu@siat.ac.cn; hy.wang1@siat.ac.cn; paul.chu@cityu.edu.hk