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MXene-Assisted Ablation of Cells with a Pulsed Near-Infrared Laser

Sergiy Kyrylenko, Oleksiy Gogotsi, Ivan Baginskiy, Vitalii Balitskyi, Veronika Zahorodna, Yevheniia Husak, Ilya Yanko, Mykolay Pernakov, Anton Roshchupkin, Mykola Lyndin, Bernhard B. Singer, Volodymyr Buranych, Alexander Pogrebnjak, Oksana Sulaieva, Oleksandr Solodovnyk, Yury Gogotsi, Maksym Pogorielov*

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Abstract

Innovative therapies are urgently needed to combat cancer. Thermal ablation of tumor cells is a promising minimally invasive treatment option. Infrared light can penetrate human tissues and reach superficial malignancies. MXenes are a class of 2D materials that consist of carbides/nitrides of transition metals. The transverse surface plasmons of MXenes allow for efficient light absorption and light-to-heat conversion, making MXenes promising agents for photothermal therapy (PTT). To date, near-infrared (NIR) light lasers have been used in PTT studies explicitly in a continuous mode. We hypothesized that pulsed NIR lasers have certain advantages for the development of tailored PTT treatment targeting tumor cells. The pulsed lasers offer a wide range of controllable parameters, such as power density, duration of pulses, pulse frequency, and so on. Consequently, they can lower the total energy applied and enable the ablation of tumor cells while sparing adjacent healthy tissues. We show for the first time that a pulsed 1064 nm laser could be employed for selective ablation of cells loaded with $Ti_3C_2T_x$ MXene. We demonstrate both low toxicity and good biocompatibility of this MXene *in vitro*, as well as a favorable safety profile based on the experiments *in vivo*. Furthermore, we analyze the interaction of MXene with cells in several cell lines and discuss possible artifacts of commonly used cellular metabolic assays in experiments with MXenes. Overall, these studies provide a basis for the development of efficient and safe protocols for minimally invasive therapies for certain tumors.

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