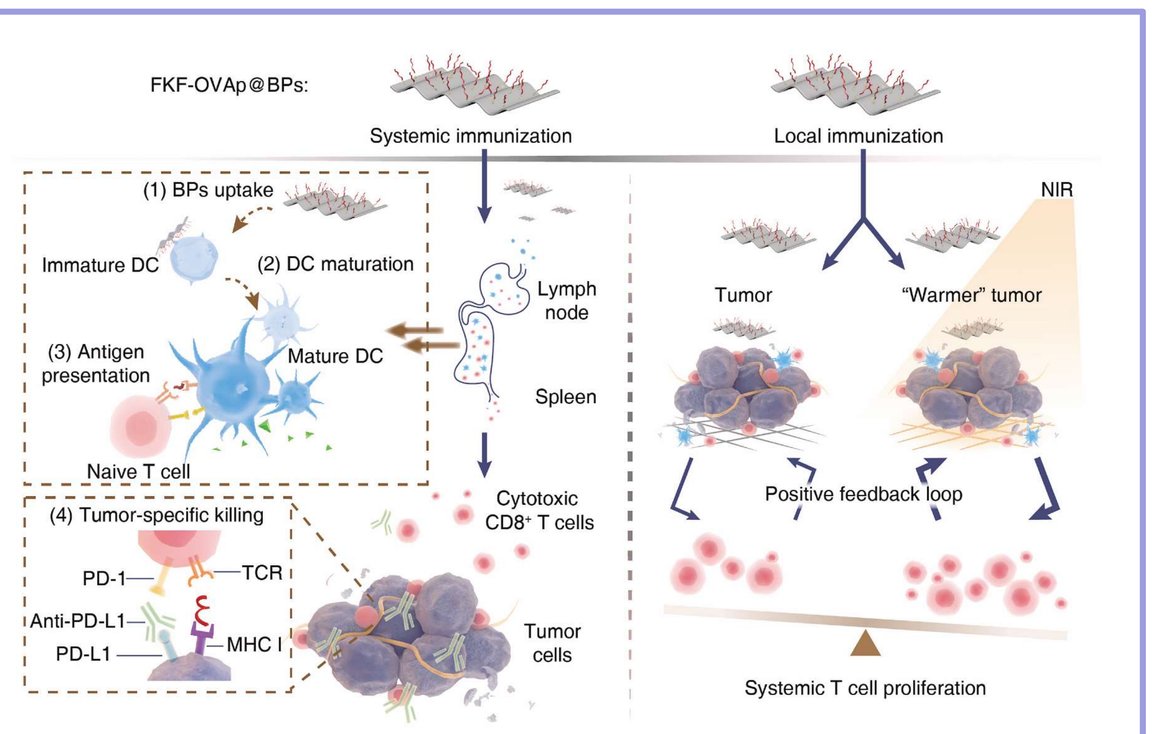
Key Laboratory of Bioorganic Phosphorus Chemistry
& Chemical Biology (Tsinghua University), Ministry of Education
https://doi.org/10.17952/37EPS.2024.P2235

Surface peptide-modified black phosphorus nanosheets: a novel multifunctional nanoadjuvant

Tian-Yang Wang,[a] Wen-Hao Li,[a] Xue-Feng Yu,[b]* Yan-Mei Li[a]*

a Department of Chemistry, Key Lab of Bioorganic Phosphorus Chemistry & Chemical Biology (Ministry of Education), Tsinghua University, Beijing, 100084, P.R. China.
b Materials and Interfaces Center, Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, Shenzhen, 518055, P.R. China.
E-mail addresses: xf.yu@siat.ac.cn (Xue-Feng Yu), liym@mail.tsinghua.edu.cn (Yan-Mei Li).

The basic components of cancer vaccines include antigens and adjuvants. Antigens determine the specificity of cancer vaccines, while adjuvants can enhance the immunogenicity of antigens and activate immune responses. Nanoplatforms can effectively enhance the lymph node targeting, antigen presentation and immune activation of vaccines. Black phosphorus nanosheets (BPs) are novel two-dimensional nanomaterials with good biodegradability and biosafety. However, the immunogenicity and application of BPs themselves remain to be further studied. Here, we developed a method for peptide modification on the surface of BPs. FKF tripeptide modification increases the loading capacity of BPs for antigens peptide, forming a simplified component nanovaccine (FKF-OVAp@BP). Surface peptide modification improved the lymph node enrichment and T cell activation of BPs. The photothermal effects of BPs also effectively enhanced their ability to activate immune responses. In addition, FKF-OVAp@BP had a good synergistic effect with immune checkpoint therapy.



Scheme 1. Black phosphorus nanosheets (BPs) as novel adjuvant nanomaterials for cancer vaccines.

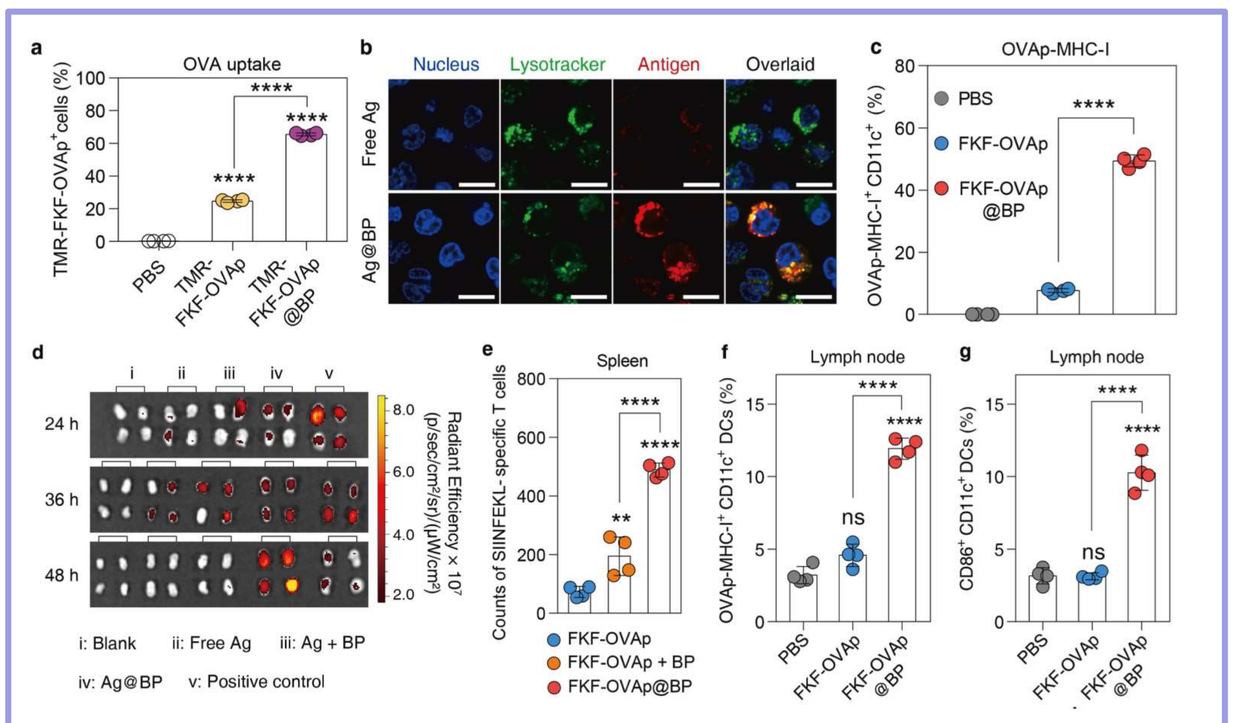


Figure 2. BPs promote antigen uptake and comprehensive immune activation of cytotoxic T lymphocyte (CTL) responses *in vivo*.

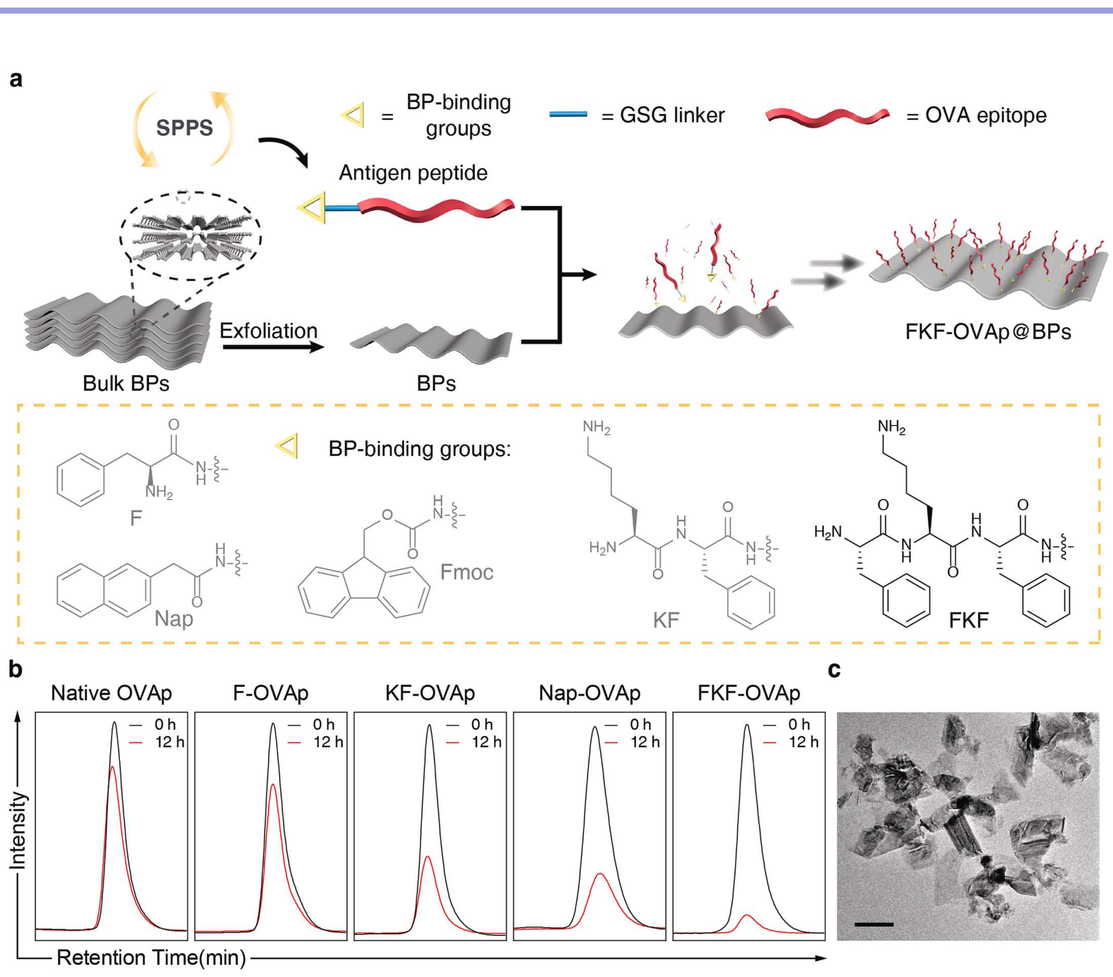


Figure 1. BPs serve as a high loading platform for peptide antigen.

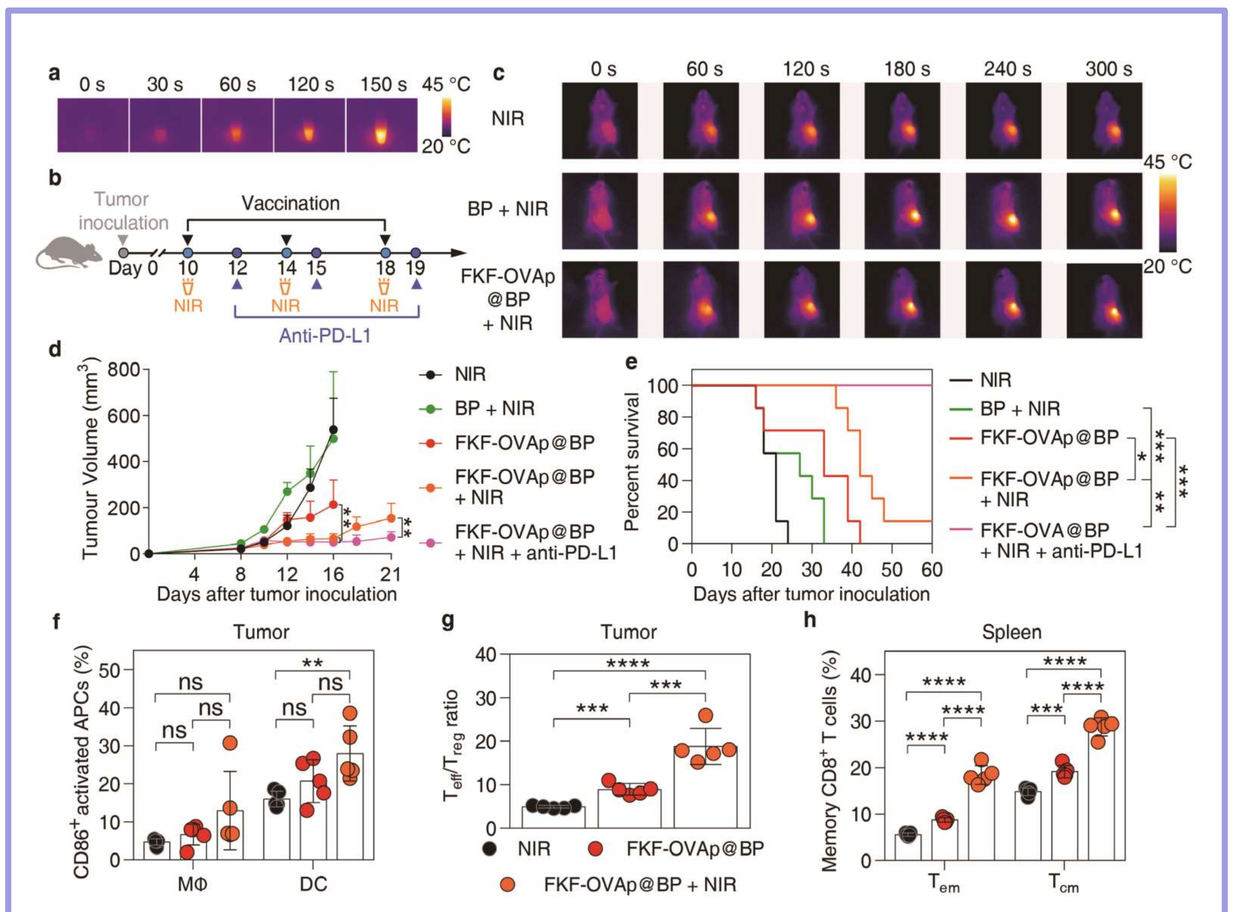


Figure 3. The use of photothermal effects in BP vaccination produced an NIR-improved antitumor effect of BP nanovaccine treatment, which synergized with checkpoint blockade therapy.

Acknowledge: This work was supported by the National Key R&D Program of China (2019YFA0904200, 2018YFA0507600), and the National Natural Science Foundation of China (21672126, 21975280), and Guangdong Special Support Program (2017TX04C096).

Reference: ［1］Li, W. H.; Yu, X. F.; Li, Y. M., et al., *Biomaterials* **2021,** *273*, 120788.