Photothermal Scaffolds of Black Phosphorus Nanosheets and Gelatin for Biomedical Applications

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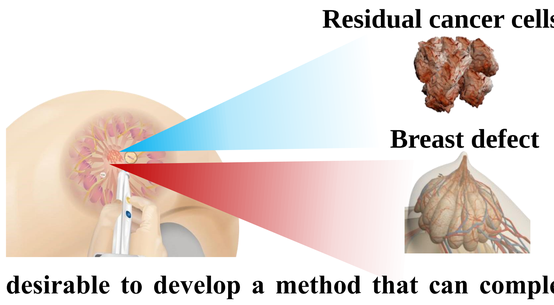
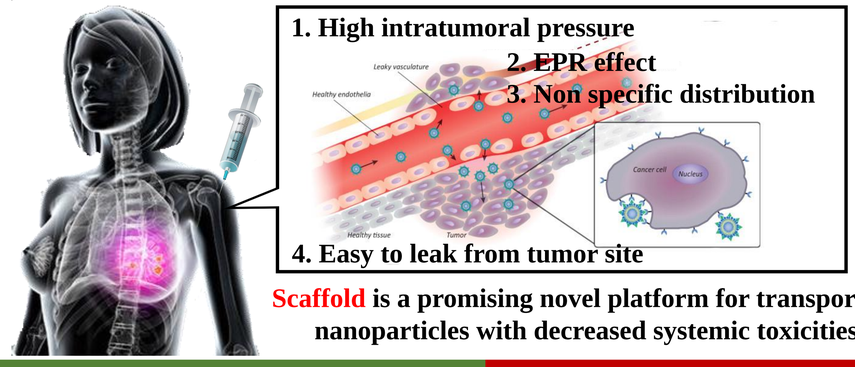
Research background

Surgical intervention against breast cancer



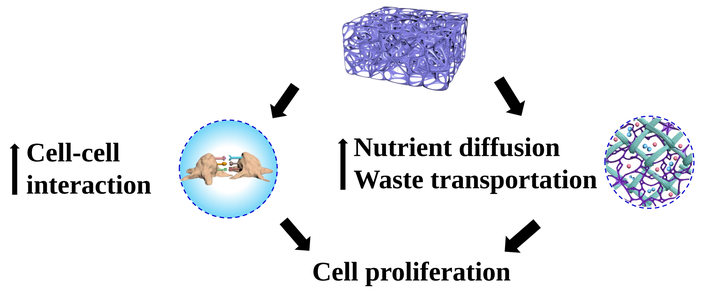
It is desirable to develop a method that can completely **kill cancer cells** and **support breast reconstruction**

Injection of free nanoparticle against residual cancer cells



Scaffold is a promising novel platform for transporting nanoparticles with decreased systemic toxicities

3D porous scaffold

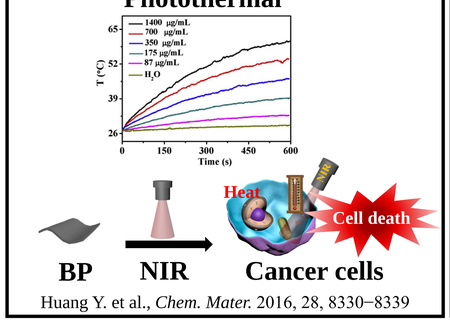


3D scaffolds are considered a **platform** for adipose tissue regeneration

Previous studies

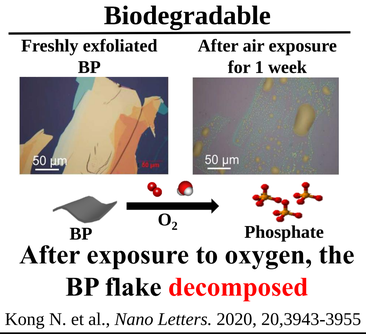
Black phosphorus (BP) attractive properties

Photothermal



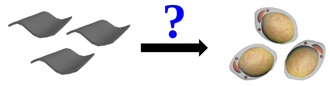
Huang Y. et al., *Chem. Mater.* 2016, 28, 8330−8339

Biodegradable



After exposure to oxygen, the BP flake decomposed

Kong N. et al., *Nano Letters.* 2020, 20,3943-3955

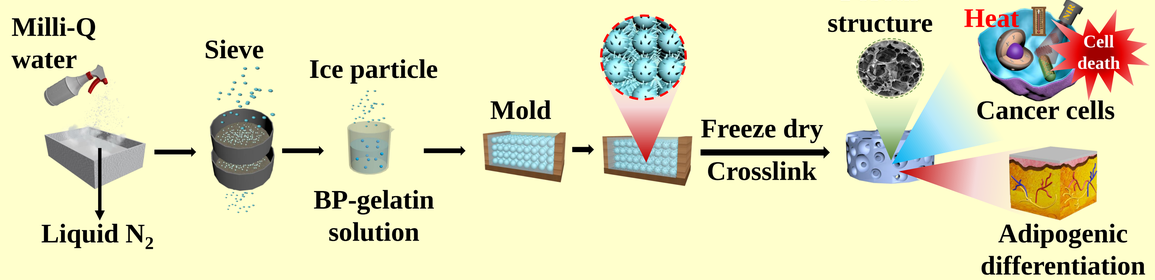


It remains unclear whether BP promotes adipose tissue regeneration

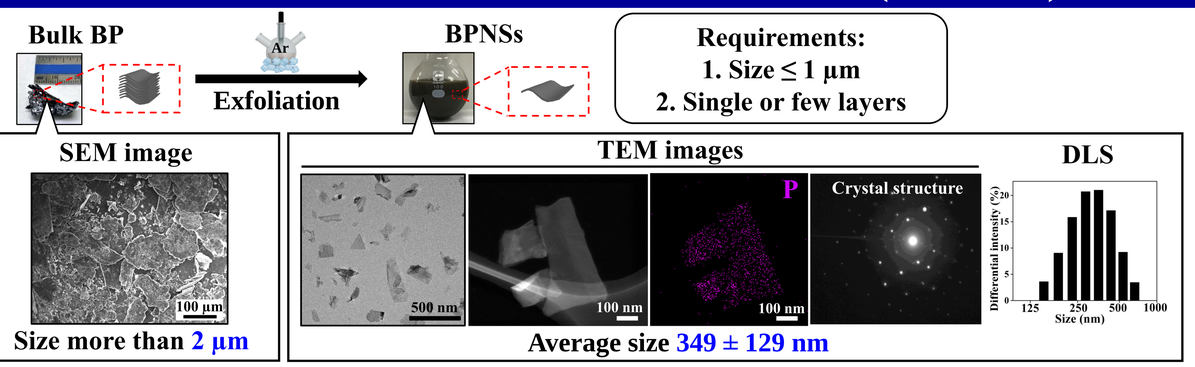
Immobilization of **BP** to the **porous scaffolds** should be explored

Research objectives and methods

- **Prepare gelatin/BP porous scaffolds**
- **Investigate their effects on the breast cancer cells and human mesenchymal stem cells (hMSCs) for ablating cancer cells and promoting adipose tissue regeneration**

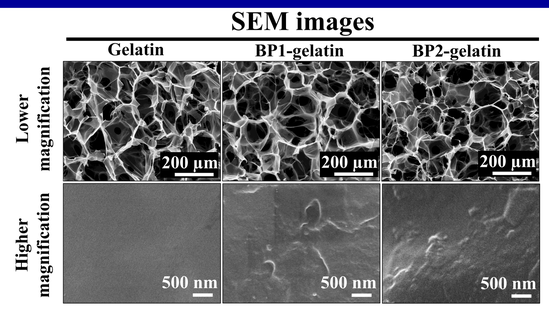


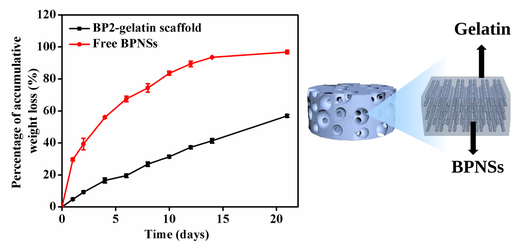
Characterization of BP nanosheets (BPNSs)



After exfoliation, there was a **reduction** both in size and number of layers

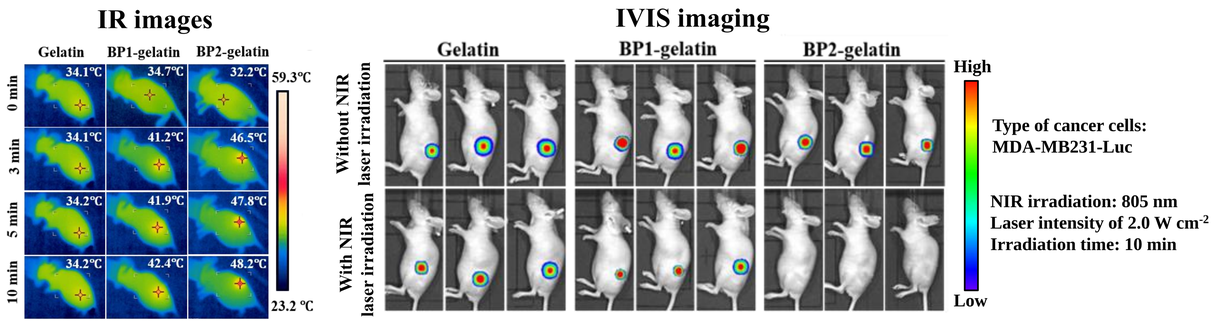
Characterization of scaffolds





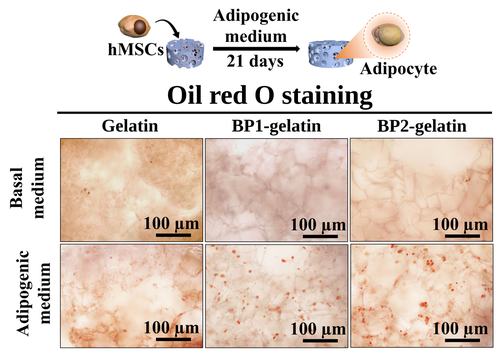
- **All of the scaffolds had the high porous and well interconnected structure**
- **The addition of BP made the pore surface rougher**
- **The gelatin matrix had protective effect against the degradation of BPNSs**

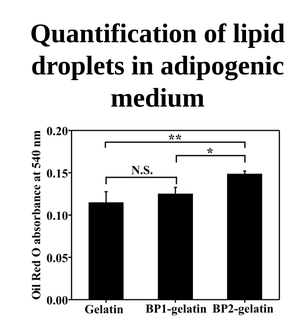
Effects on breast cancer cells

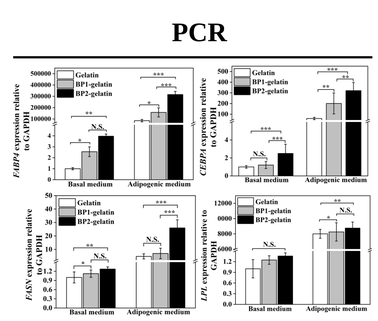


- **Temperature change under NIR irradiation: BP2-gelatin > BP1-gelatin > gelatin**
- **Anticancer efficacy: BP2-gelatin > BP1-gelatin > gelatin**

Effects on adipogenic differentiation







Significant difference: *p < 0.05; **p < 0.01; **p < 0.001; N.S. = no significant difference. n = 3.

Effects on adipogenic differentiation: BP2-gelatin > BP1-gelatin > gelatin

Conclusions and future perspective

- **The composite scaffolds had a well-interconnected pore structure with the BPNSs homogenously distributed on the pore walls.**
- **The composite scaffold with a high amount of BPNSs could effectively kill breast cancer cells. Moreover, the composite scaffolds facilitated the adipogenic differentiation of hMSCs.**
- **The composite scaffolds are anticipated to serve as a platform for ablation against breast cancer cells and the reconstruction of adipose tissue.**

Reference and acknowledgement

L. Sutrisno, H. Chen, Y. Chen, T. Yoshitomi, N. Kawazoe, Y. Yang and G. Chen*, Composite scaffolds of black phosphorus nanosheets and gelatin with controlled pore structures for photothermal cancer therapy and adipose tissue engineering, *Biomaterials*, 2021, 275, 120923.

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