Preparation of composite scaffolds of folic acid-conjugated gelatin and gold nanoparticles for photothermal therapy

Huajian Chen[1,2], Xiuhui Wang[1], Naoki Kawazoe[1], Guoping Chen[1,2]

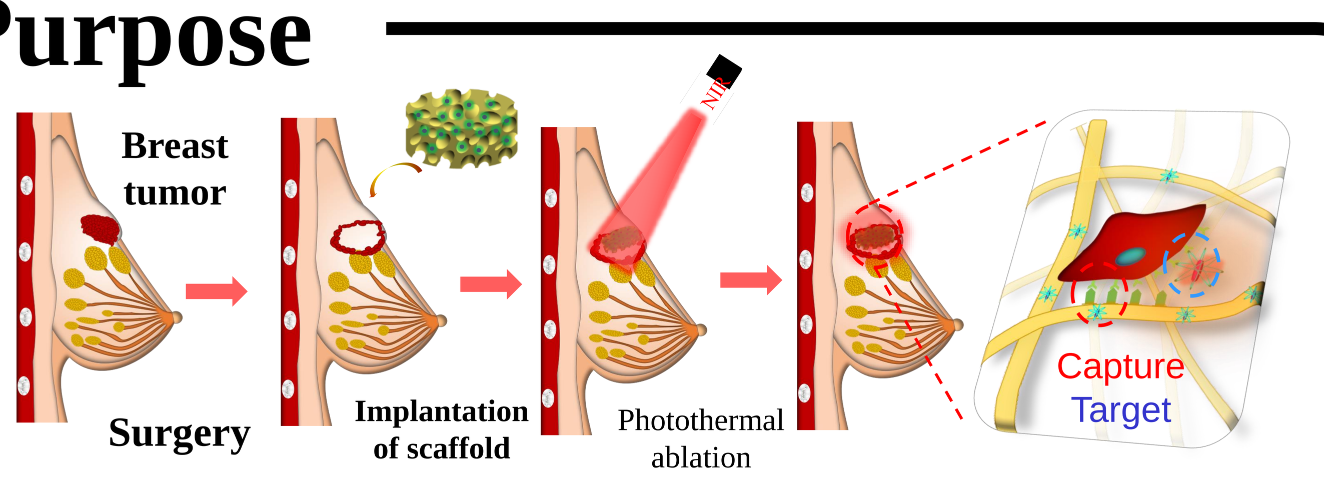
1 Tissue Regeneration Materials Group, Research Center for Functional Materials, National Institute for Materials Science, Tsukuba, Japan

2 Department of Materials Science and Engineering, Graduate School of Pure and Applied Sciences, University of Tsukuba, Tsukuba, Japan

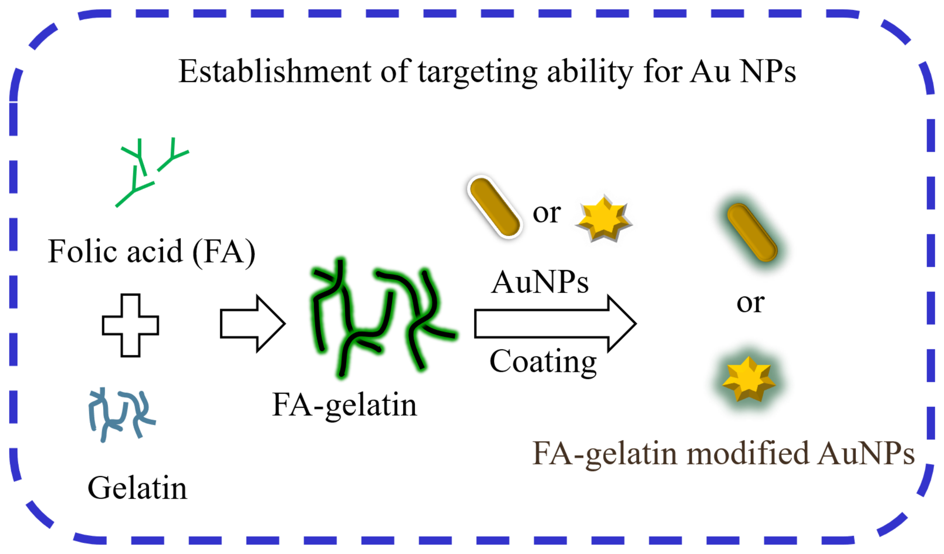
Introduction

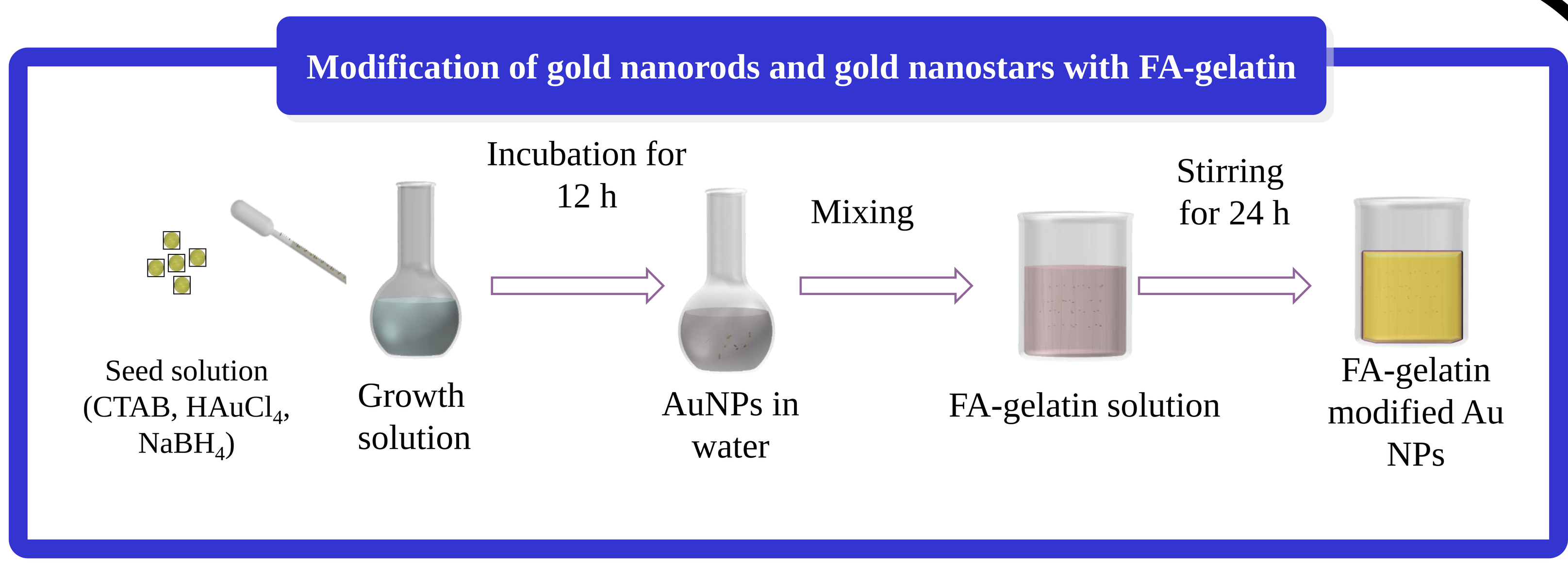
Photothermal therapy (PTT) has been developed as a useful therapeutic method for cancer treatment. Gold nanoparticles can convert near-infrared light into heat and they are good photothermal conversion agents for PTT. Recently, porous scaffold have been used as an effective carrier for localized delivery of photothermal conversion agents. Furthermore, it is highly desirable to increase the capture ability of cancer cells in photothermal scaffolds while minimize their damage to healthy cells. Therefore, in this study, gold nanoparticles (AuNPs) were prepared and modified with cancer cells recognition ligand, folic acid (FA). The FA-modified AuNPs were hybridized with FA-functionalized gelatin to prepare AuNPs/FA-gelatin composite scaffolds for targeting cancer cells and photothermal therapy.

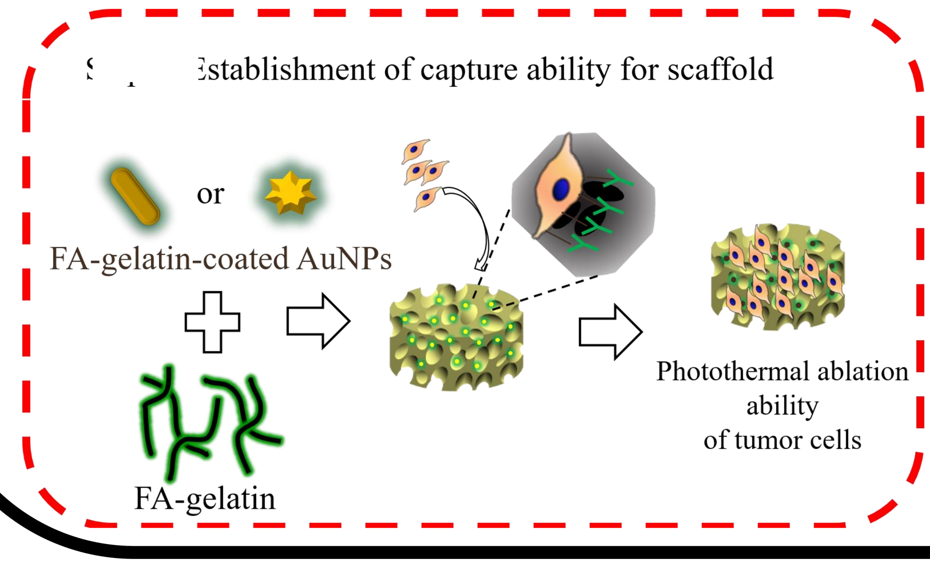
Purpose

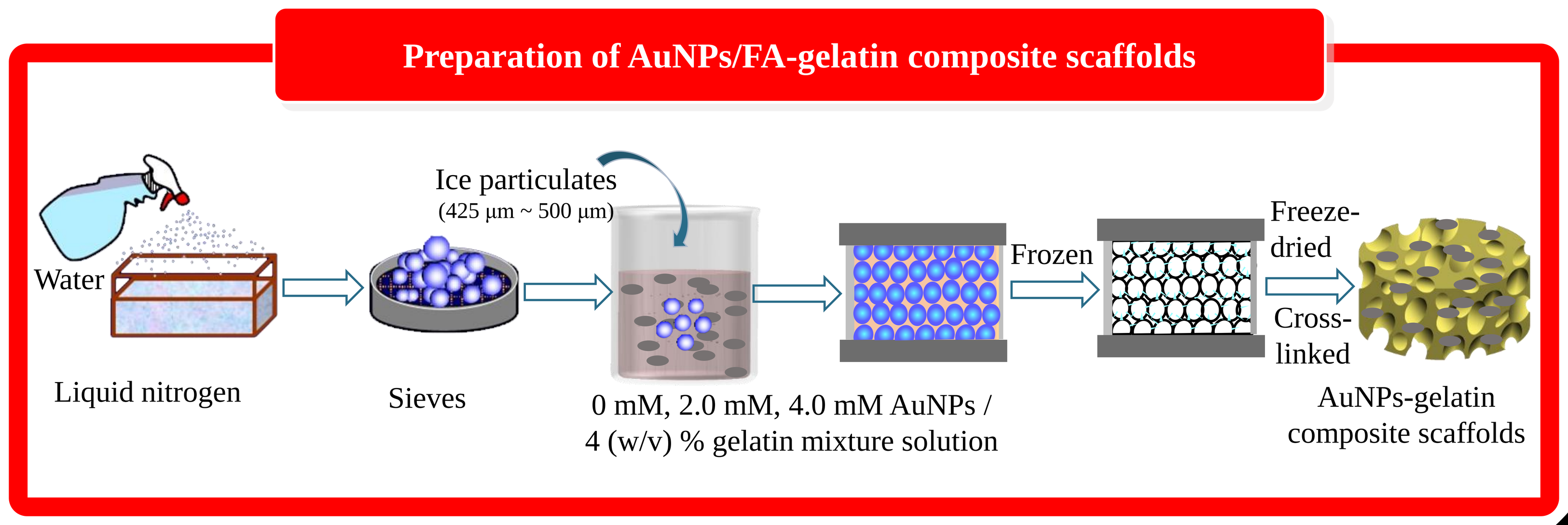


Method



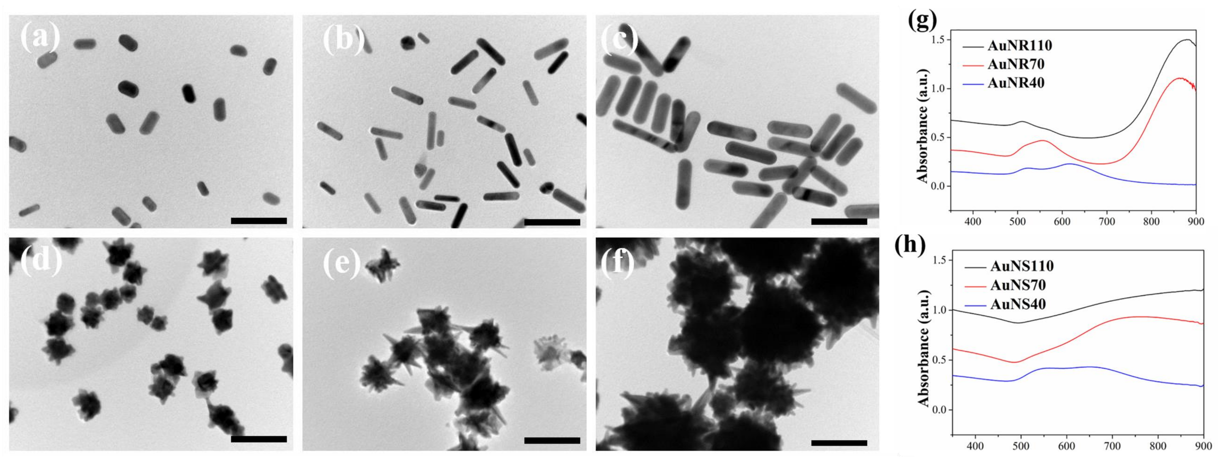






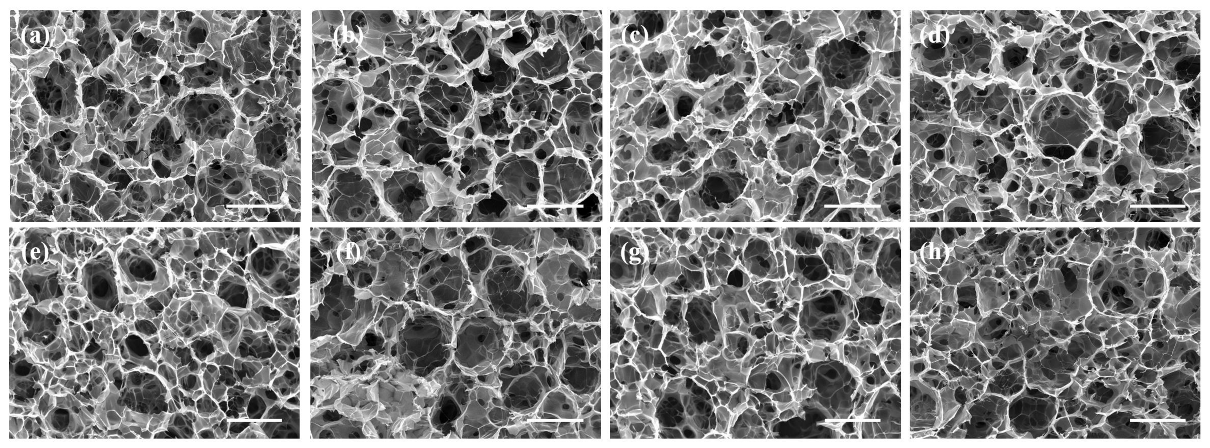
Characterization

Characterization of different gold nanoparticles



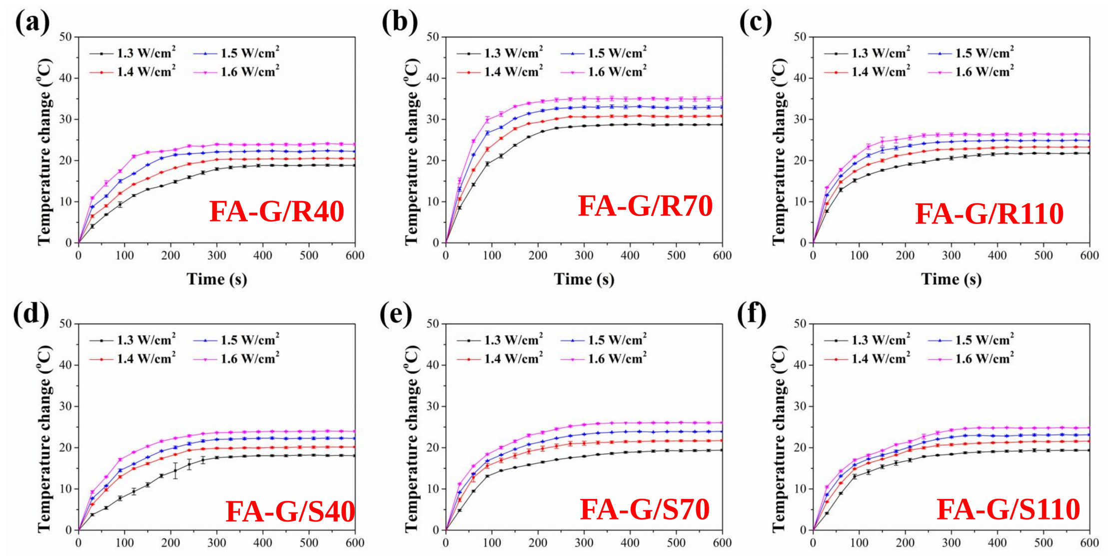
Different sizes and shapes of gold nanoparticles has observed by TEM. (a to c) gold nanorod with 40, 70, 110nm, (d to f) gold nanostar with 40, 70, 110nm, (g and h) UV-Vis spectrum of different gold nanoparticles.

Characterization of different scaffolds



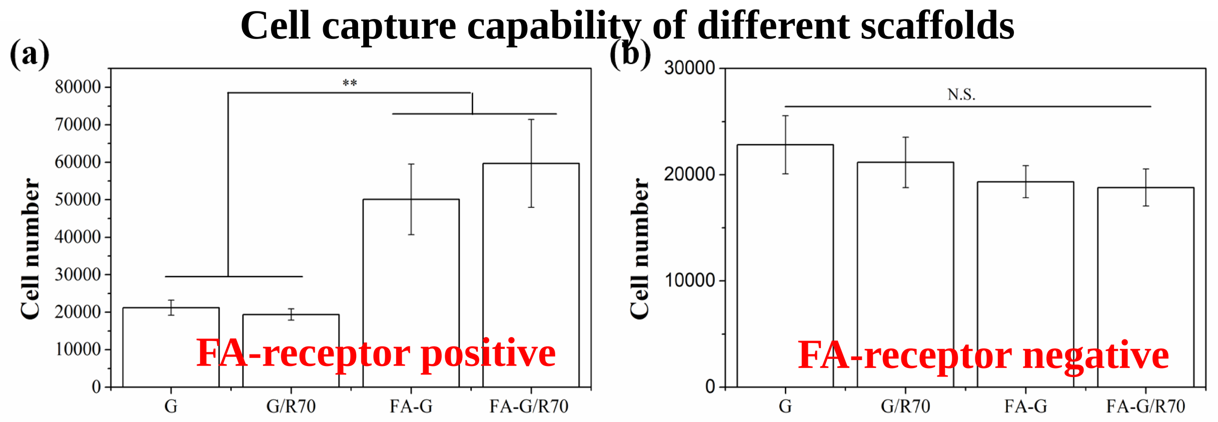
Porous scaffolds immobilized with different gold nanoparticles. (a) G, (b) FA-G, (c to e), (f to h) FA-G with S40,S70,S110. FA-G with R40, R70, R110

Photothermal conversion of different scaffolds



After irradiating different scaffolds with NIR laser for 10 min, the FA-G/R70 shows highest temperature change because of the highest photothermal conversion capability of gold nanorod with 70 nm.

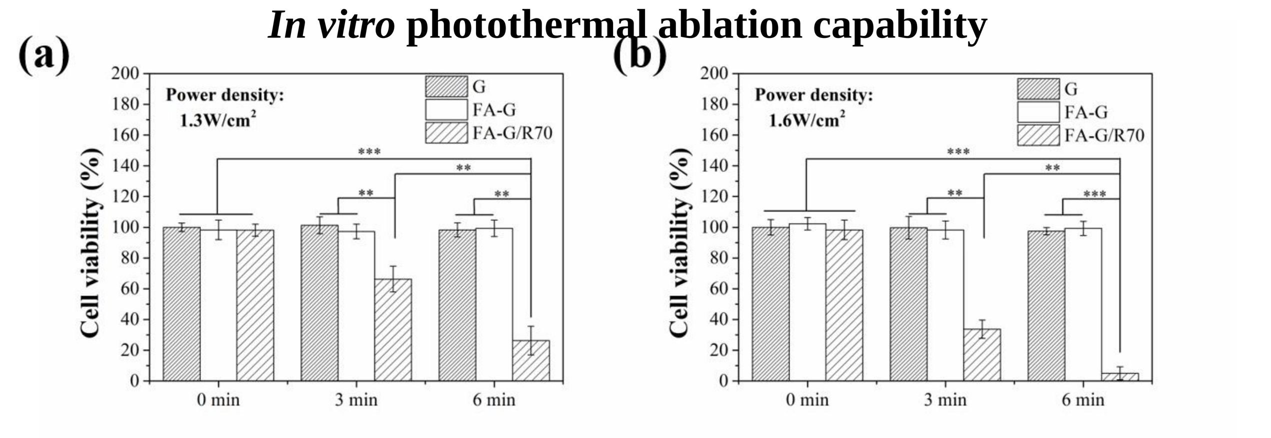
Cell capture capability of different scaffolds

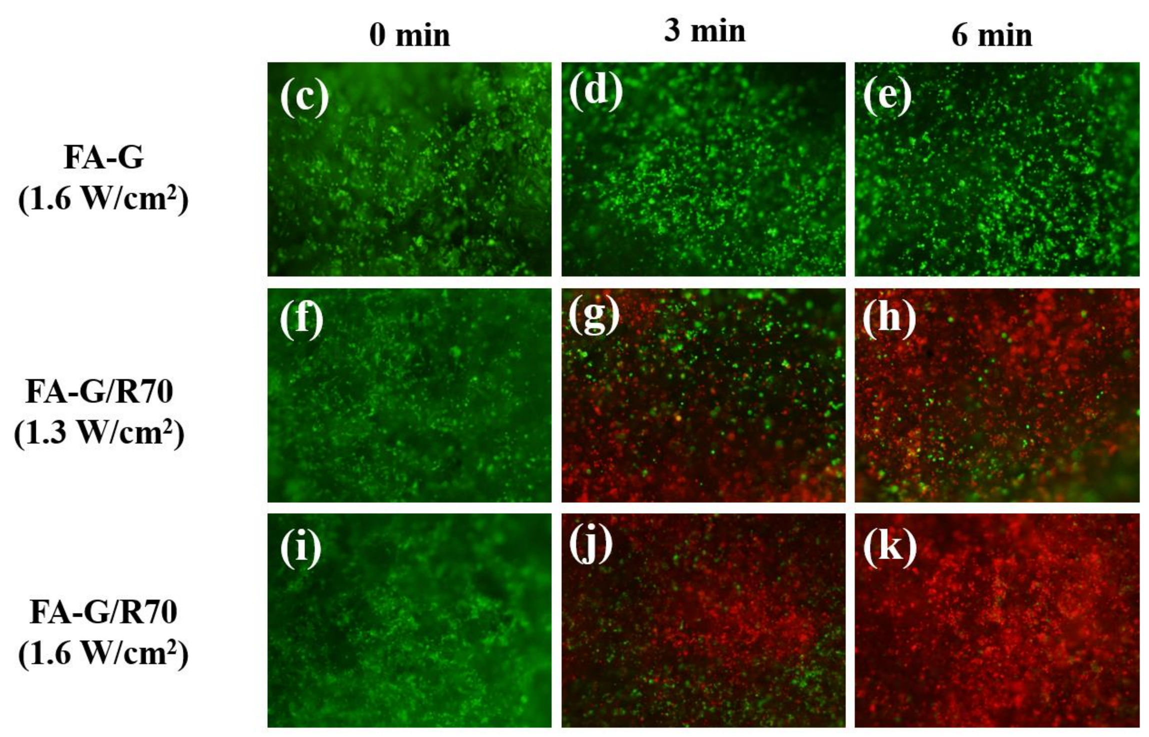


FA conjugated gelatin scaffolds are able to capture more FA-receptor positive cancer cells compared to gelatin scaffolds, but there is no difference when scaffolds are capturing FA-receptor negative cells.

In vitro therapy

In vitro photothermal ablation capability

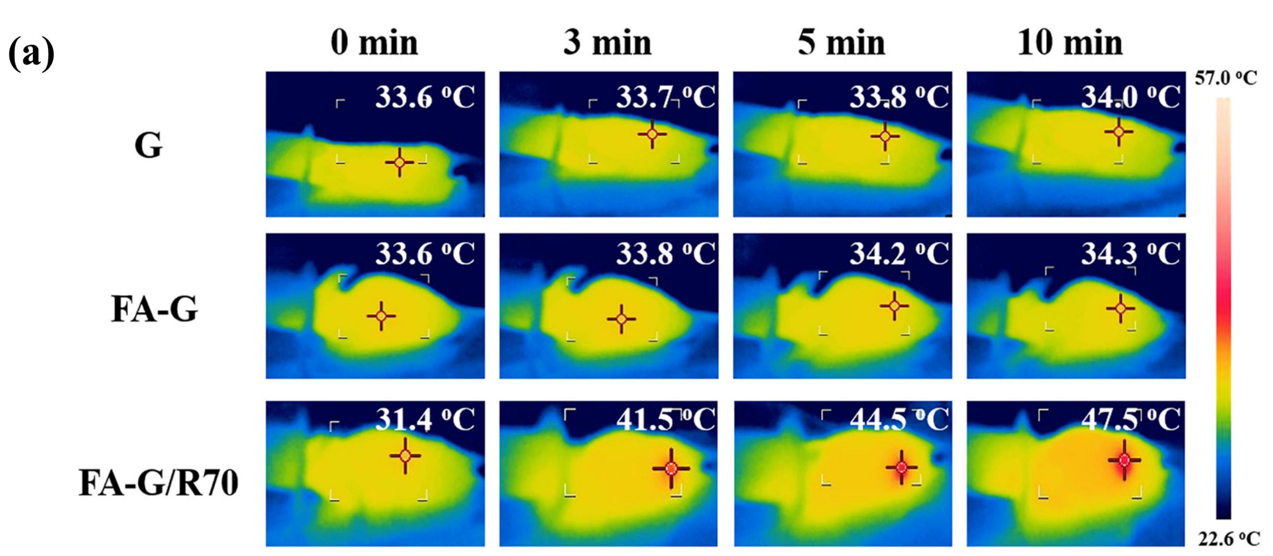




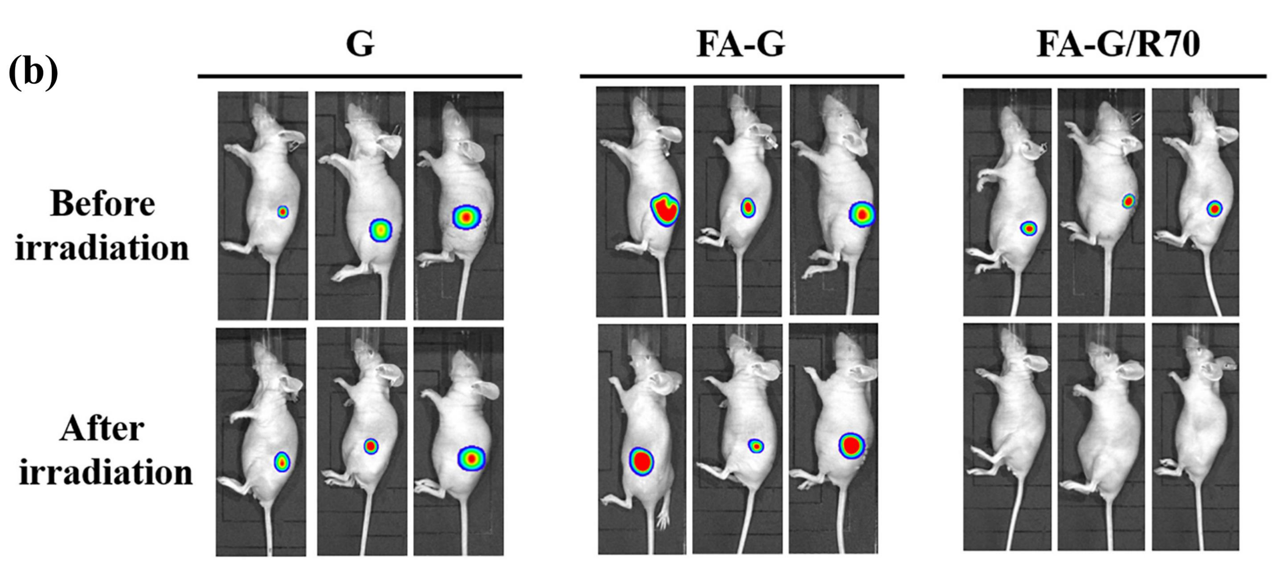
The results show that scaffolds have good biocompatibility. With laser irradiation, the FA-G/R70 scaffold shows inhibition effect to cancer cells.

In vivo therapy

In vivo photothermal conversion effect



In vivo photothermal ablation capability



The FA-G/R70 shows rapid temperature increasing in vivo after NIR laser irradiation. IVIS imaging monitors the therapeutic effect of FA-G scaffolds immobilized with or without R70. The results show that the FA-G/R70 is able to entirely ablate cancer cells.

Conclusion

1. FA-functionalized gelatin–AuNPs composite scaffolds were prepared by hybridizing FA-conjugated gelatin and FA-modified AuNPs.
2. Porous scaffolds had been successfully prepared by ice particulates porogen method.
3. The composted scaffolds showed good photothermal properties and capture capacity for FA receptor–positive cancer cells.
4. The *in vivo* animal experiments demonstrated that the FA-G/R70 composite scaffold could kill cancers under NIR laser irradiation.

Acknowledgements

This research was supported by JSPS KAKENHI Grant Number 19H04475.