New 2D Nanomaterials For Cancer Phototherapy

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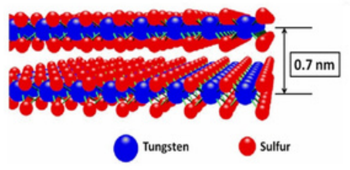
Nanotechnologies

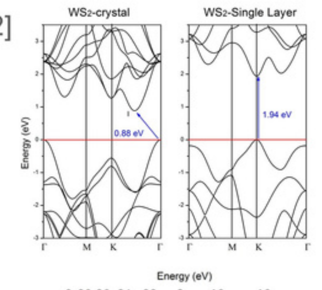
Why 2D Materials for Cancer Cell Therapy?

- Photothermal therapy (PTT) for cancer cells requires agents with high absorbance in near infrared (NIR) region and sizes smaller than 200 nm.
- Transition metal dichalcogenides (TMDs) are 2D nanosheets which are easily separated due to weak van der Waals forces between the layers [1]. Their band structures change when the TMD bulk crystal is thinned down to monolayer (thickness < 1nm), indicating that TMD bulks and nanoflakes obtain quite different optical properties. [2]
- The total surface area considerably increases when the TMD bulk powders are broken into nanoflakes, which suggests enhanced absorbance[3] and higher thermal conversion efficiency.

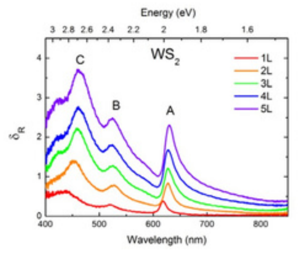
[1]



[2]

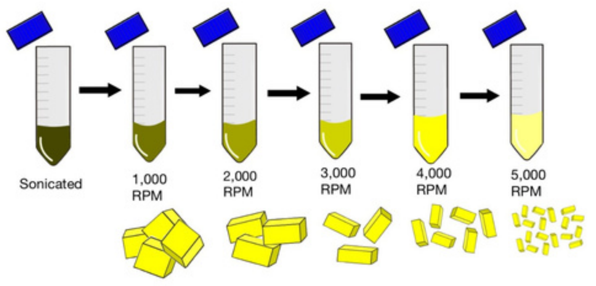


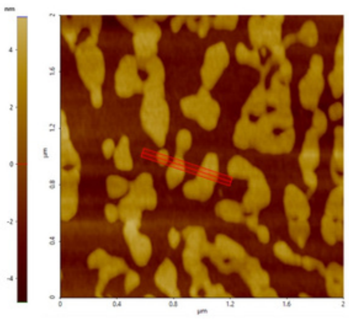
[3]

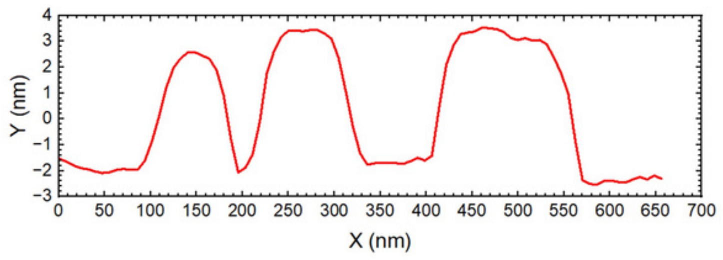


2D nanoflakes produced by Liquid Exfoliation of 2D Materials

We use ultrasonication bath and magnetic mixer to generate large amount of TMD nanoflakes in water. Followed by centrifugation at multiple speeds, we extract the 2D TMD nanoflakes with lateral size ~200 nm and thickness < 10 nm.



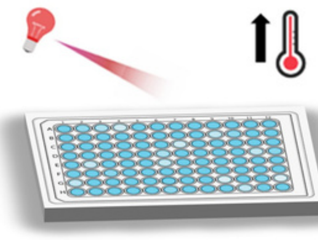


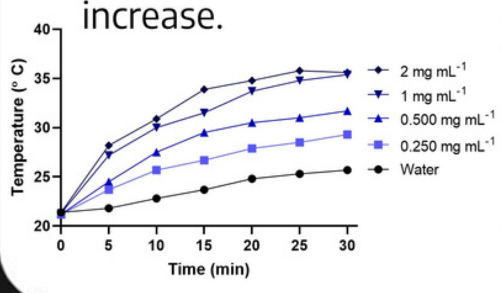


Figures from Incorvia Lab

PTT Testing

A heating system is customized with NIR LEDs to heat the 2D nanomaterial solution and measure the temperature increase.





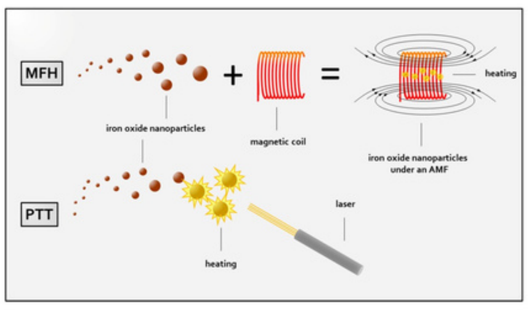
Concentration	ΔT (°C)
2 mg mL^{-1}	14.2
1 mg mL^{-1}	14.0
0.500 mg mL^{-1}	10.3
0.250 mg mL^{-1}	7.9
Water	4.3

Figures from Pinto Lab

PTT Study on Magnetic Materials

Previous research[4] shows that magnetic nanoparticles can be the agents of PTT and magnetic field hyperthermia (MFH) at the same time, which implies the potential of magnetic 2D TMDs for cancer cell therapy.

[4]



Project Goals

We aim for producing TMD nanoflakes solutions within lateral size < 200 nm, thickness < 10 nm, and concentration > 1 mg/mL. The structure of TMD nanoflakes are studied through AFM and TEM. The absorbance and photothermal conversion efficiency of the TMD solution are measured and analyzed.

References

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