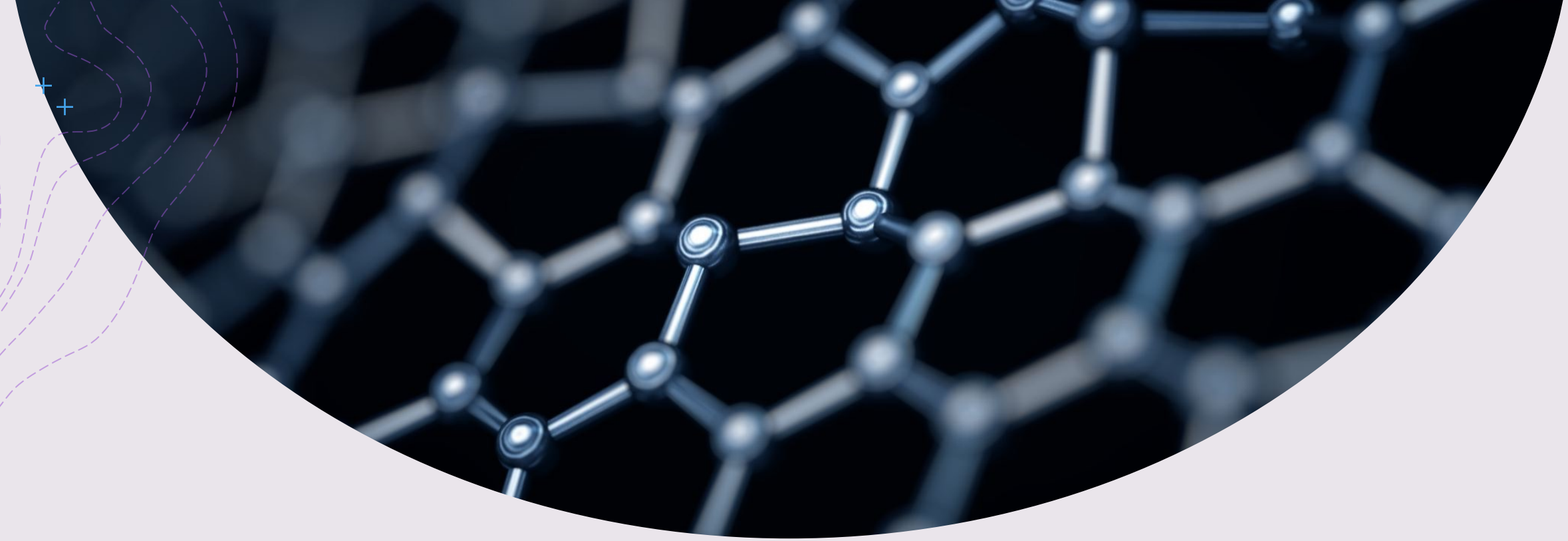
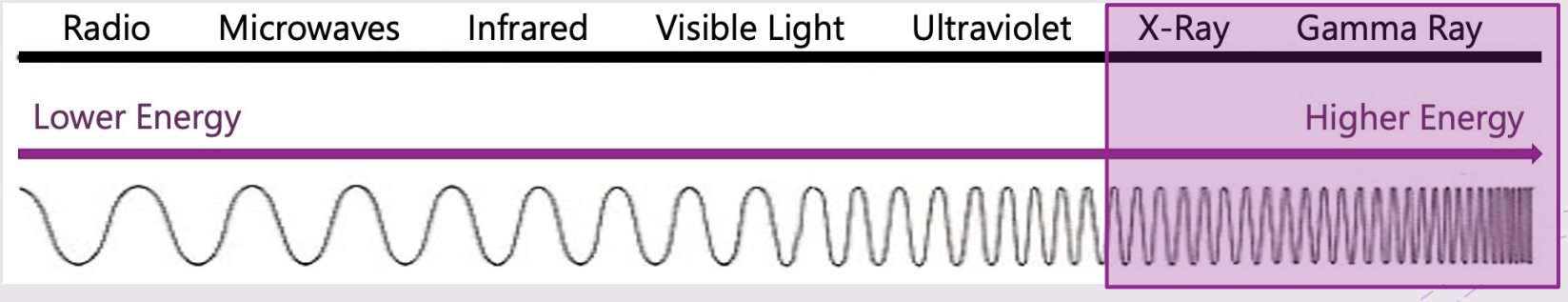


Characterization of the Photothermal Effect of Various Nanomaterials

Gretel Jordan and Dr. Anton Naumov

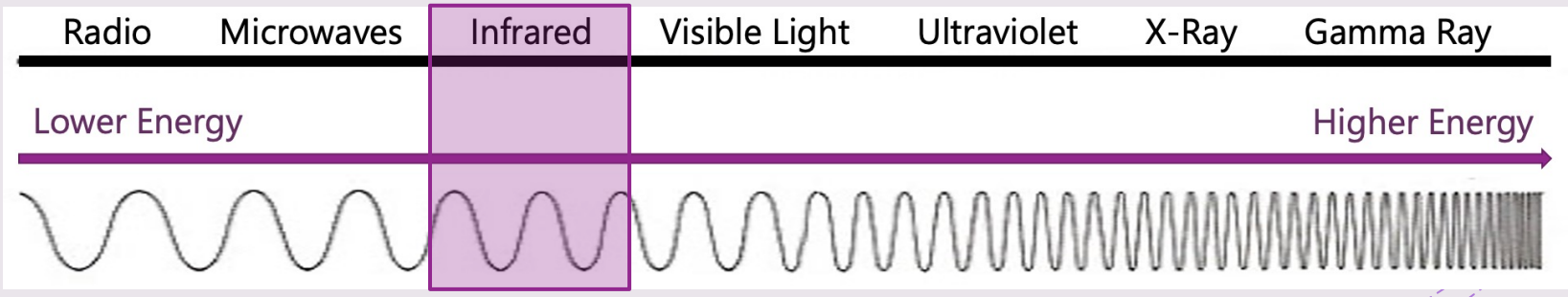
The Problem with Current Cancer Treatment Options

Current radiation therapies use high-energy waves, like x-rays and gamma rays → This inadvertently damage healthy cells → Which leads to side-effects



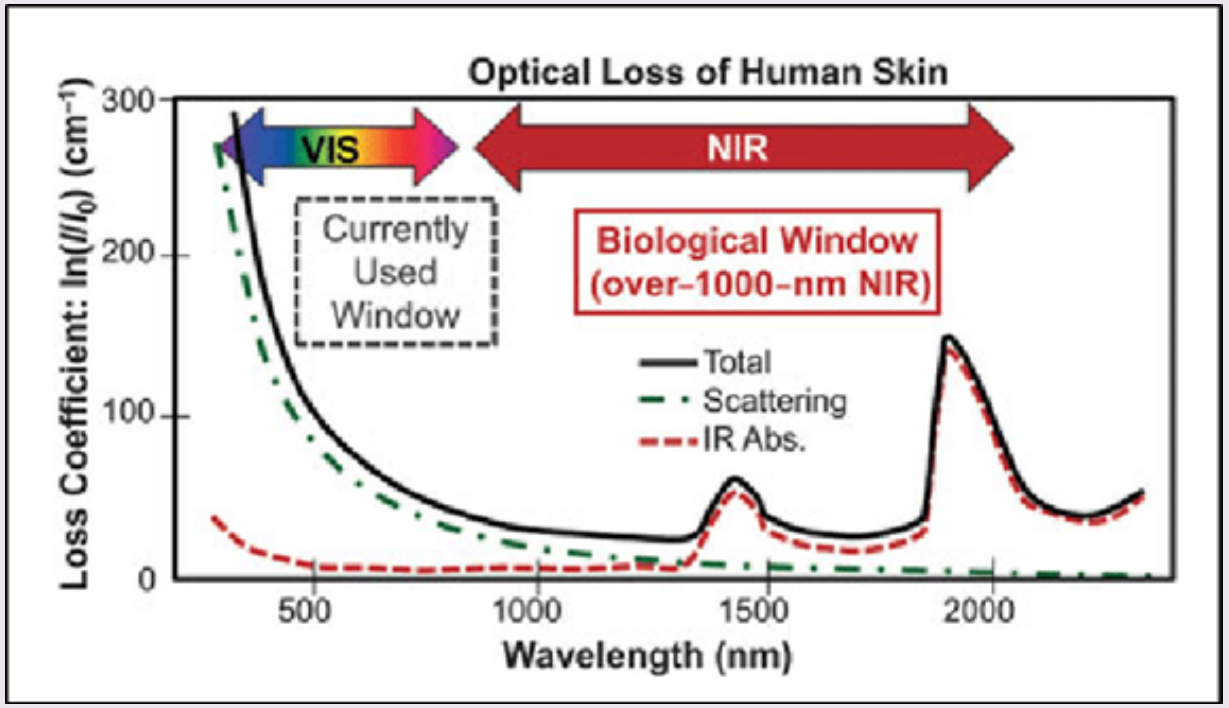
Photothermal Therapy

- Uses infrared light
- Biological tissue does not absorb much infrared
- Some nanomaterials do absorb in infrared
- These nanomaterials can be used to selectively heat cancer cells



Example of Photothermal Therapy

Hemmer, E., Vetrone, F. & Soga, K. Lanthanide-based nanostructures for optical bioimaging: Small particles with large promise. *MRS Bulletin* **39,** 960–964 (2014). https://doi.org/10.1557/mrs.2014.223



Research Purpose

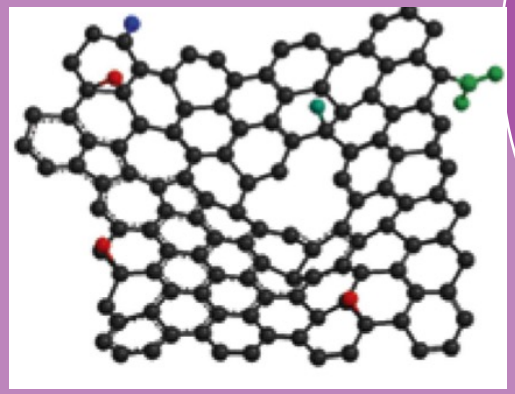
My research characterizes and compares the photothermal effect of different nanomaterials at various concentrations in aqueous media.

Reduced Graphene Oxide (rGO) Nanoparticles

Reduced Graphene Oxide

Absorbs in the near-infrared

Not water-soluble



Slightly-Oxidized Reduced Graphene Oxide

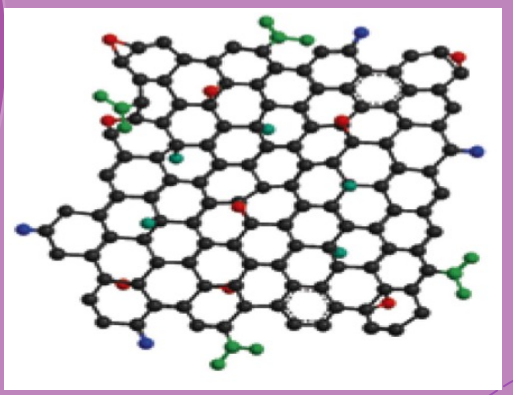
Absorbs in the near-infrared

Water-soluble

Graphene Oxide

Does not absorb in the near-infrared

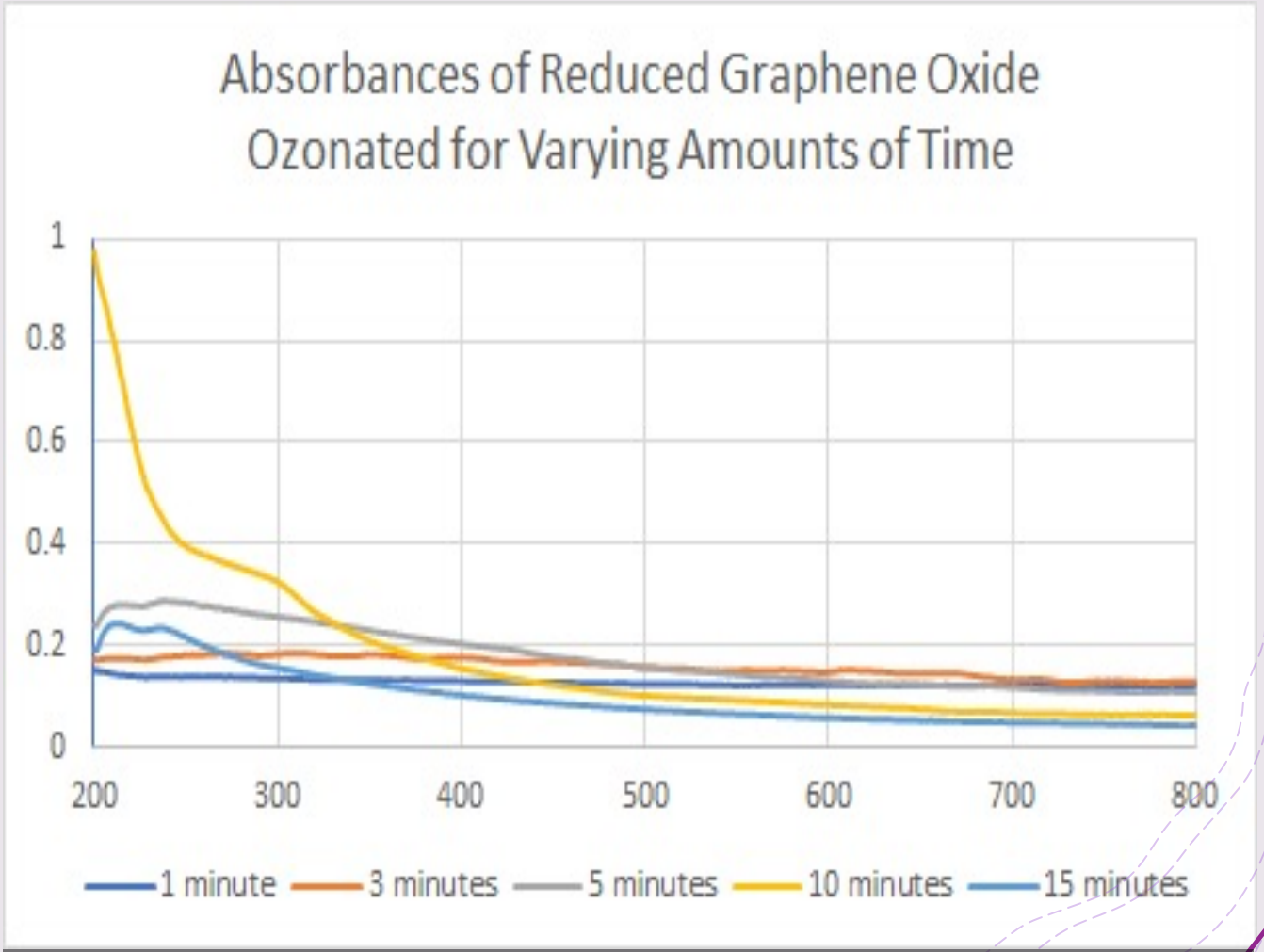
Water-soluble



Carbon
Epoxy
Carbonyl
Hydroxyl
Carboxyl

Reduced Graphene Oxide (rGO) Nanoparticles

Left to right:
rGO treated with ozone for: 1, 3, 5, 10, 15, and 25 minutes

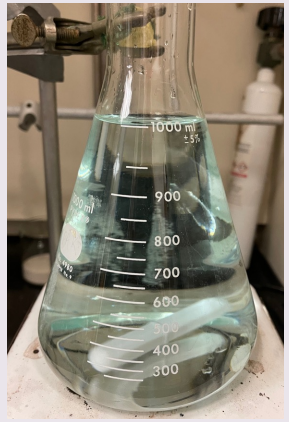


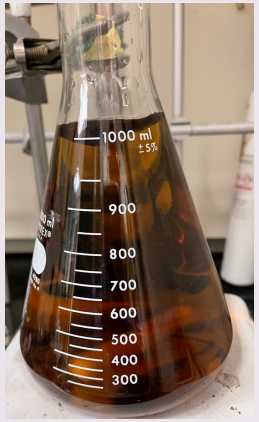
The sample ozonated for 10 minutes was chosen for the following experiments

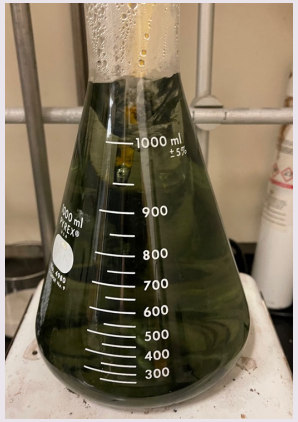
Copper (II) Sulfide Nanoparticles

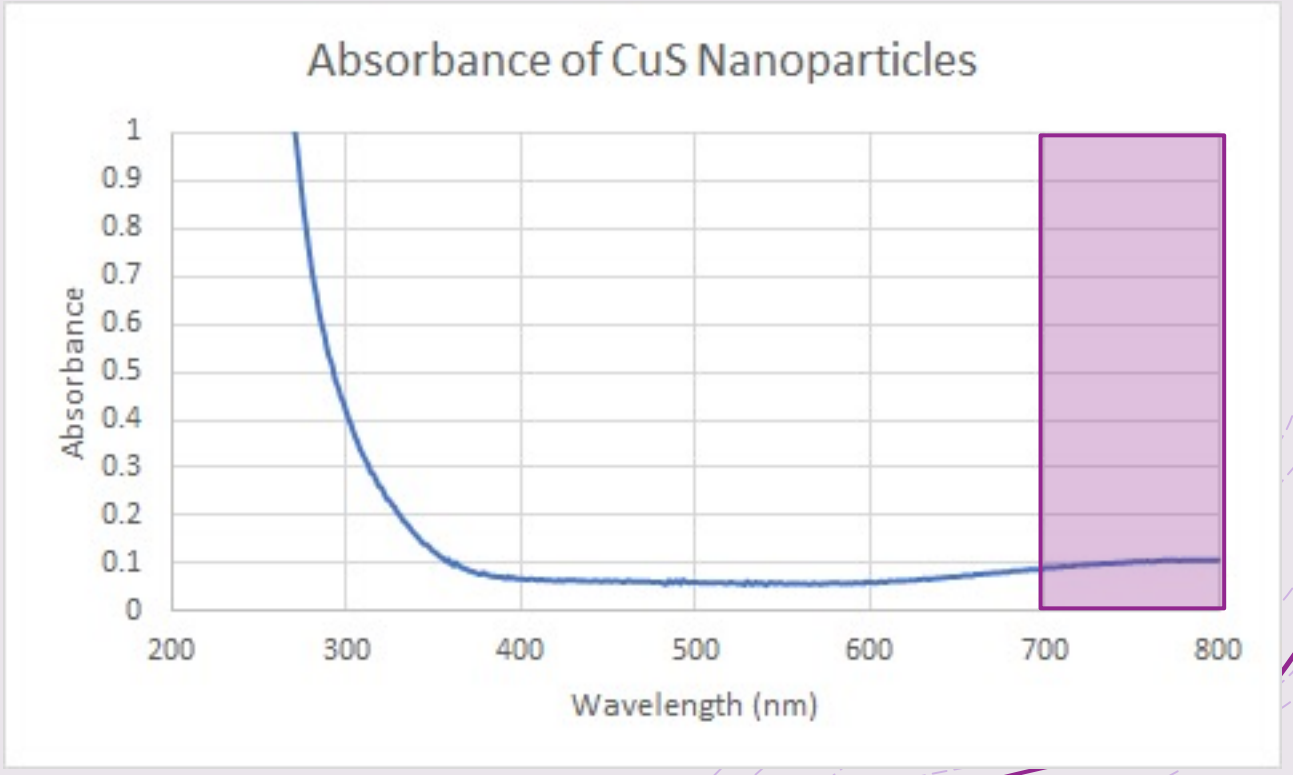
+ Water soluble
+ Synthesis reaction:

$$CuCl_2 + Na_2S \rightarrow CuS + 2Na^+ + 2Cl^-$$

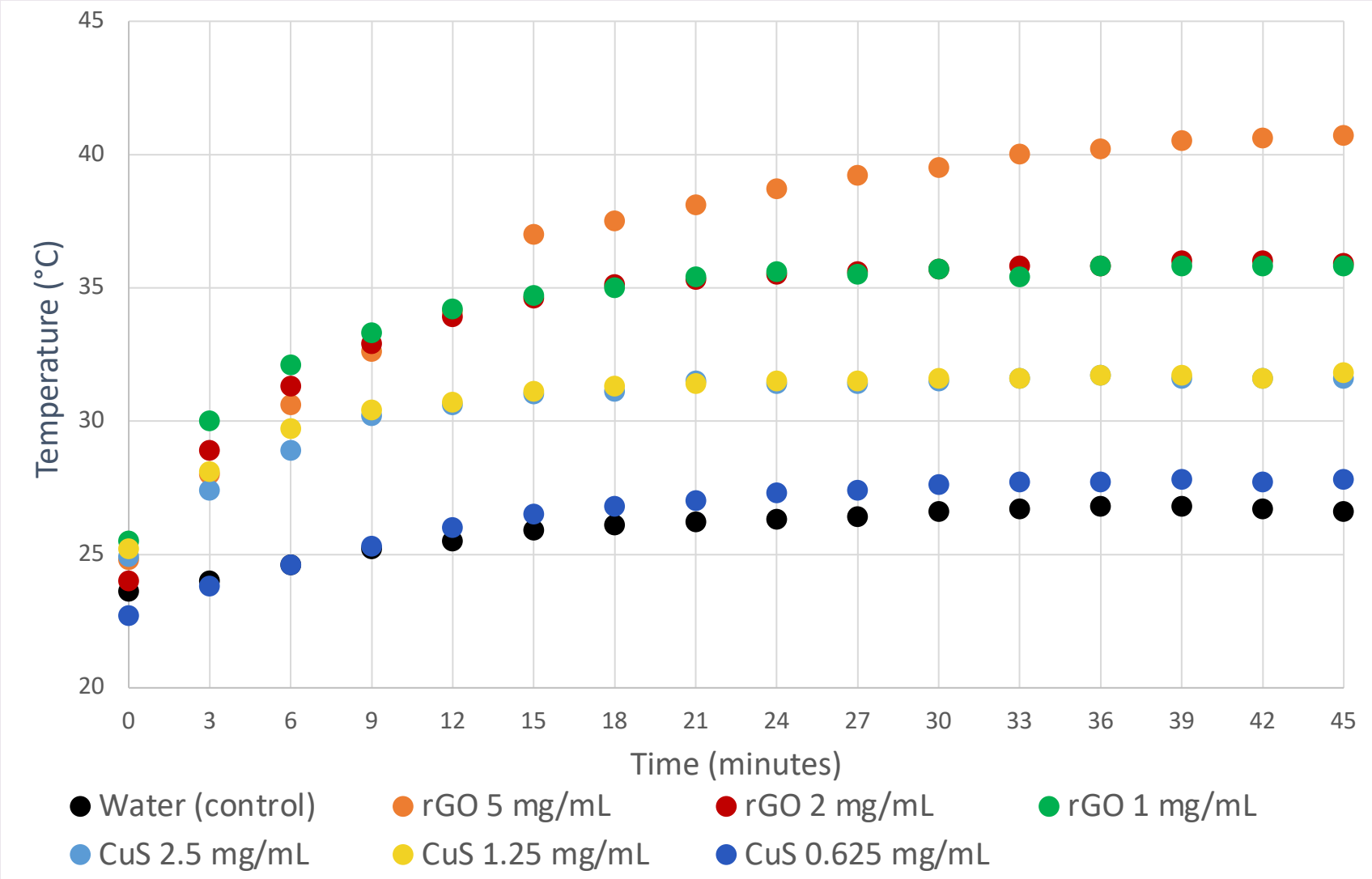




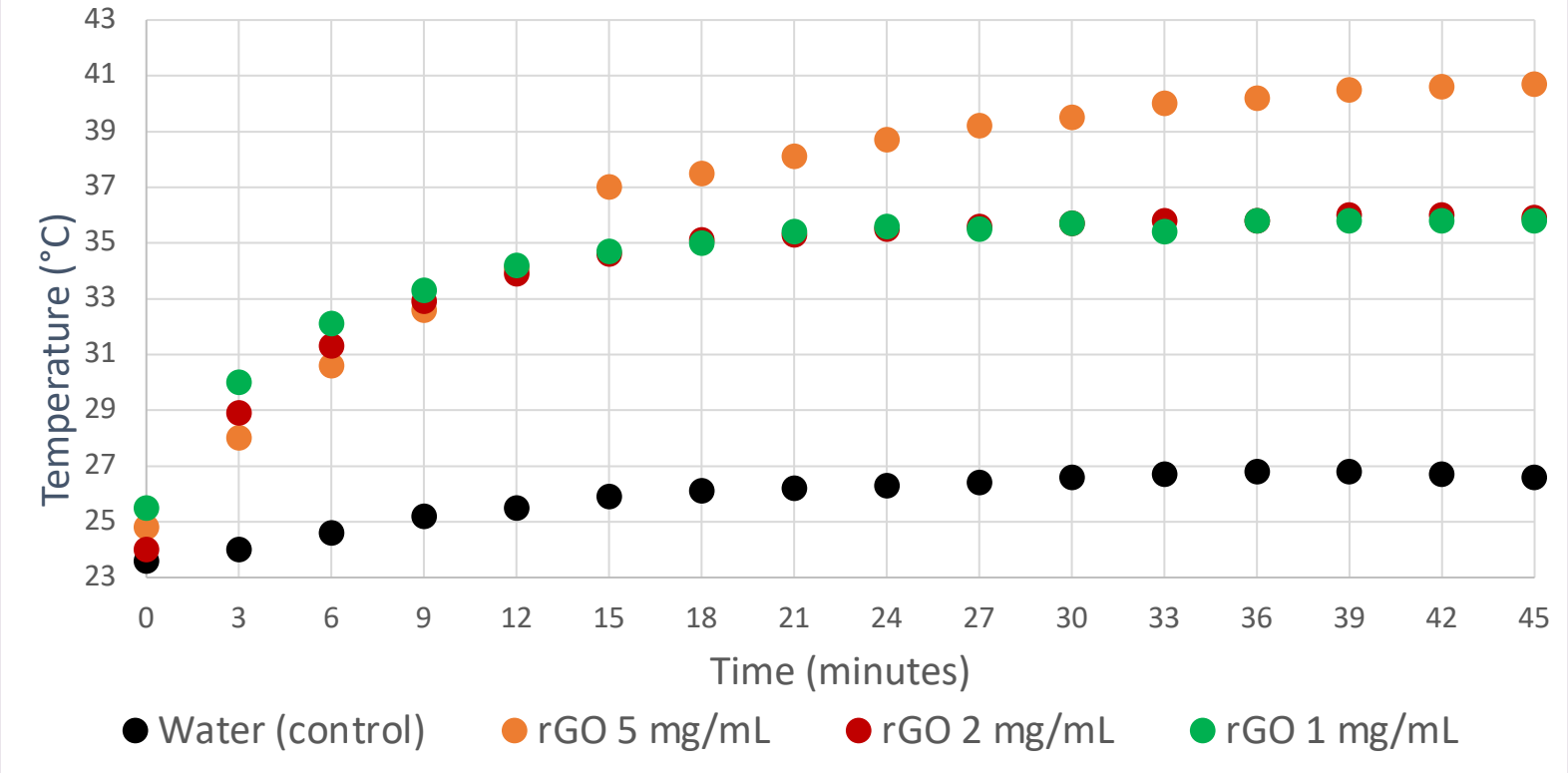




Photothermal Properties in Aqueous Media

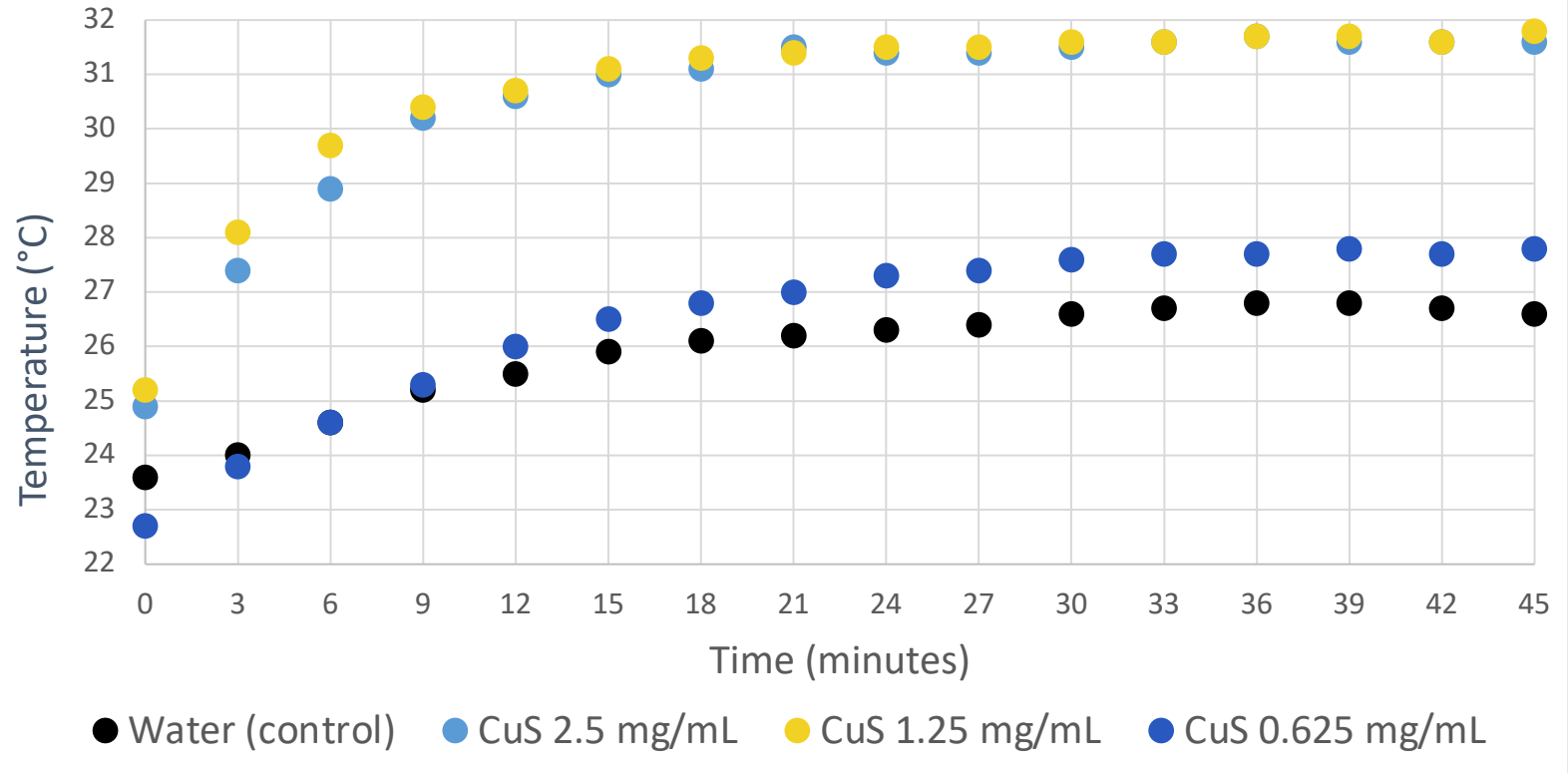


Discussion of Results - rGO



Sample	Water	rGO (5 mg/mL)	rGO (2 mg/mL)	rGO (1 mg/mL)
ΔT (°C)	3	15.9	11.9	10.3
Final Temperature (°C)	26.6	40.7	35.9	35.8

Discussion of Results - CuS



Sample	Water	CuS (2.5 mg/mL)	CuS (1.25 mg/mL)	CuS (0.625 mg/mL)
ΔT (°C)	3	6.7	6.6	5.1
Final Temperature (°C)	26.6	31.8	31.6	27.8

Future Work

GOLD NANOSPHERES

GOLD NANORODS

LIVE HELA CELL EXPERIMENTS

Summary

Characterization of photothermal effect of rGO and CuS nanoparticles

CuS had substantial photothermal effect

rGO had largest photothermal effect

Will run further experiments on these particles

SciCom Statement

Current cancer therapies have many side-effects, due to their tendencies to affect both cancerous and healthy tissue. Therapies that are able to specifically target cancer cells would greatly improve patient care. Certain nanoparticles have the property of heating up when irradiated with infrared radiation, which is less energetic than visible light and not nearly as damaging as most radiation therapies currently offered. These nanoparticles can be inserted into tumor cells and irradiated with infrared radiation to selectively heat—and kill—cancer cells. My research characterizes the ability of several nanomaterials to heat upon near-infrared irradiation.