UNAT
Ultra-small Nanohybrides for Advanced Theranostics

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Photo- & RF-induced heating of colloidal carbon dots with temperature dependent fluorescence

Vladimir Lysenko

FENNEC Team, Light–Matter Institute
UMR-5306, CNRS/UCBL

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- P. Lishchuk, I. Lysenko, A. Zaderko, V. Lisnyak, V. Skryshevsky

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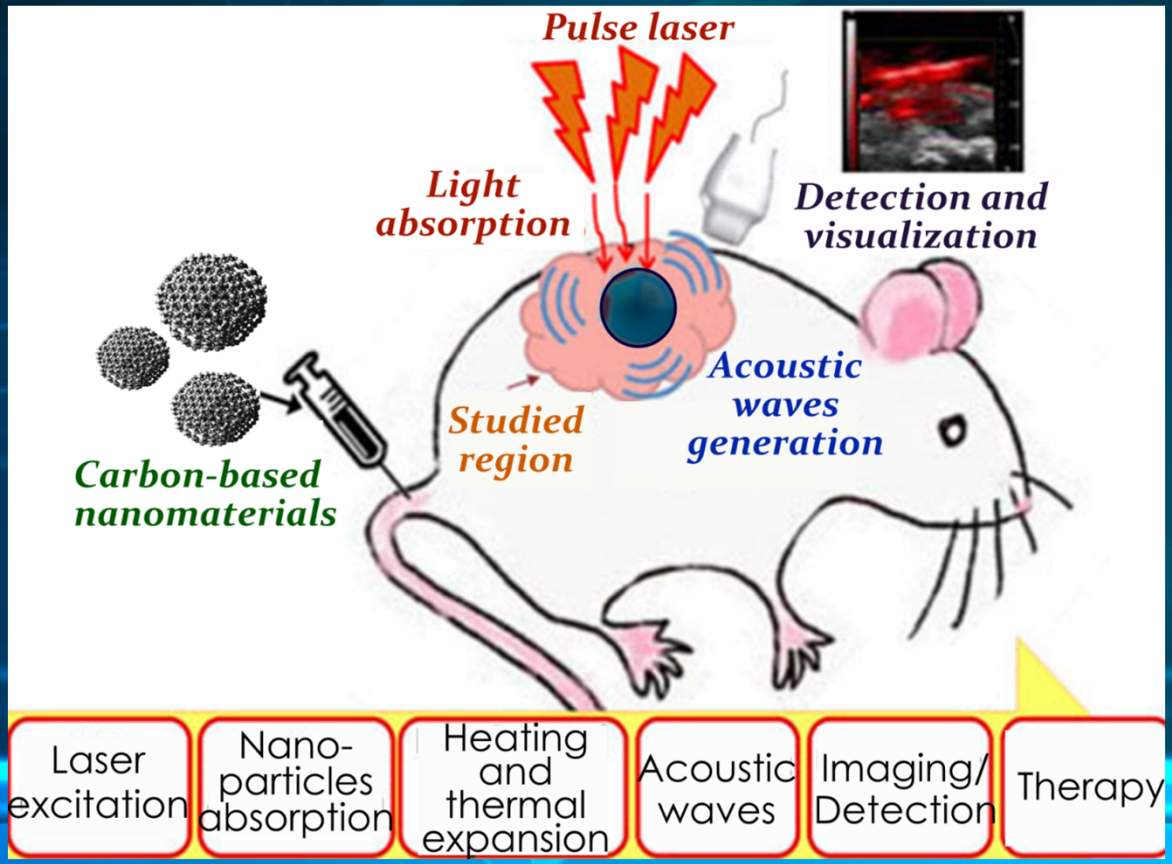
Light-Matter Institute, UMR 5306, CNRS/UCBL

Introduction to Photo-Thermal Therapy

Photo-Thermal Therapy (PTT) *employs electromagnetic radiation, most commonly in the form of NIR light or RF electromagnetic waves for the treatment of various diseases (including cancer)*



Carbon dots: synthesis and main properties

- Solvothermal synthesis from urea and citric acid
- Multicolor temperature dependent fluorescence
- Ultra small sizes: *<8 nm*
- Main advantages:
  - ✓ *Extremely stable colloids*
  - ✓ *Perfectly biocompatible at concentrations <0.5 g/L*
  - ✓ *Efficient penetration into the biological cells*

Carbon dots: characterization

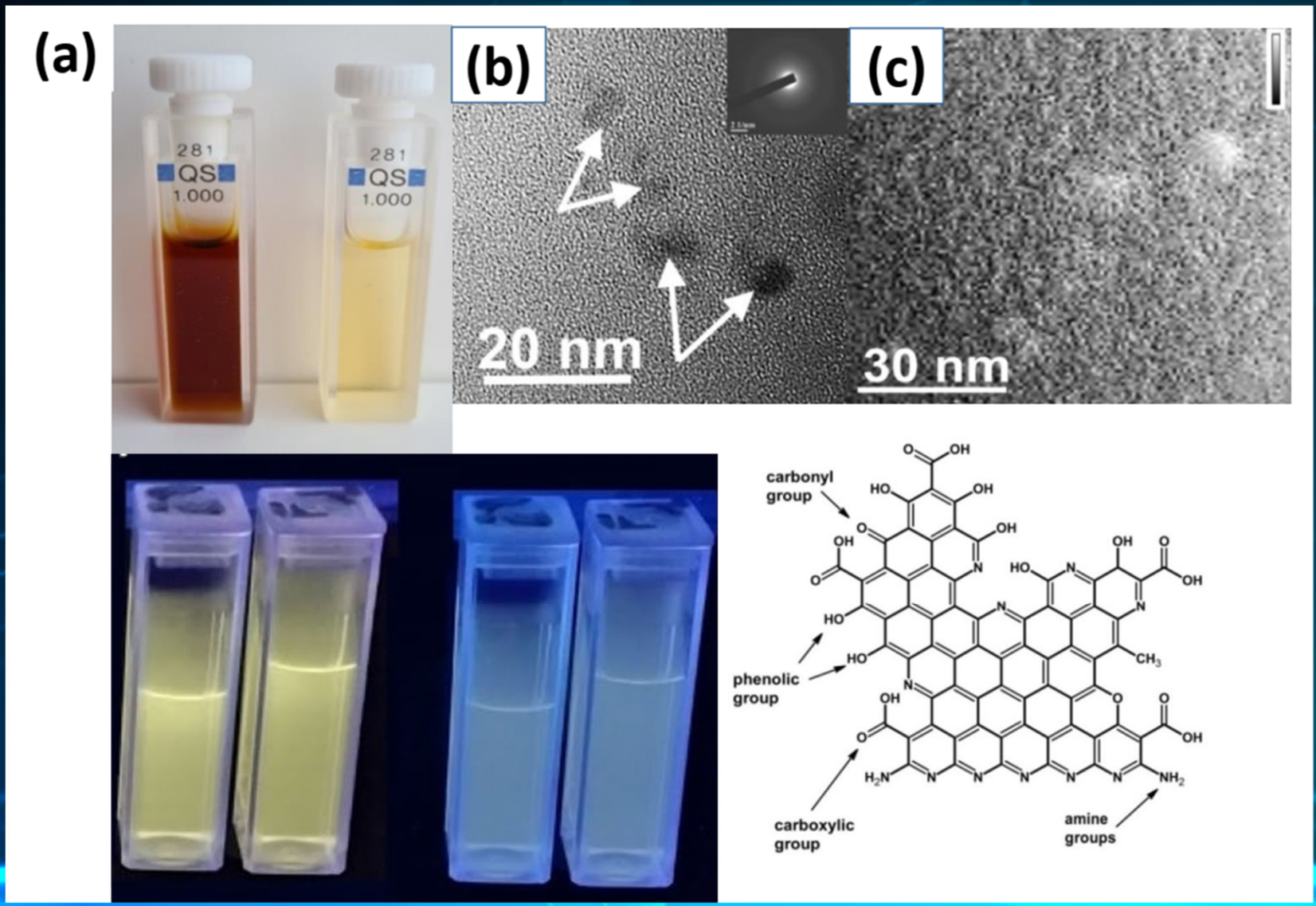


Photo-induced heating of CDs-based colloids: set-up

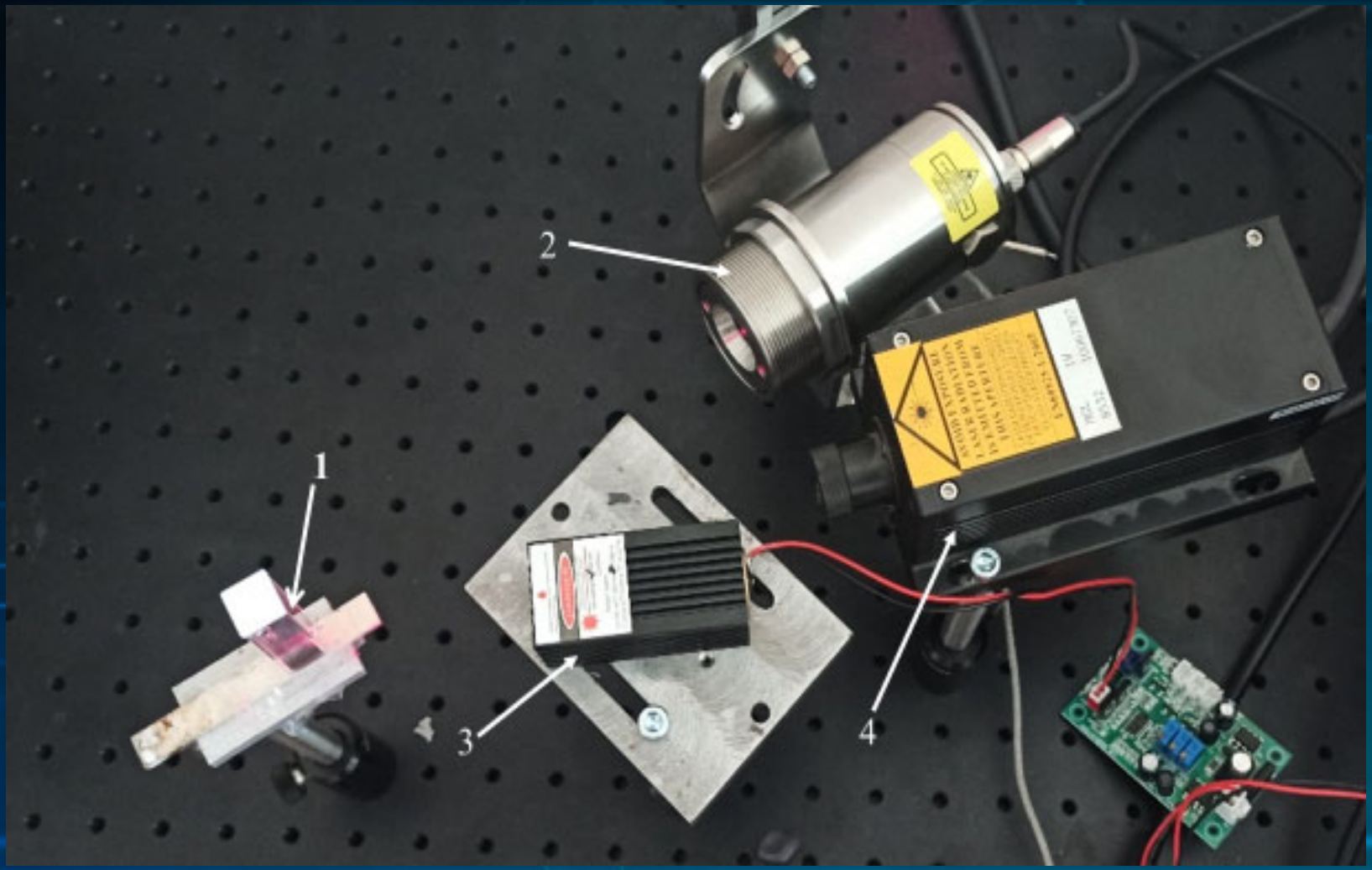
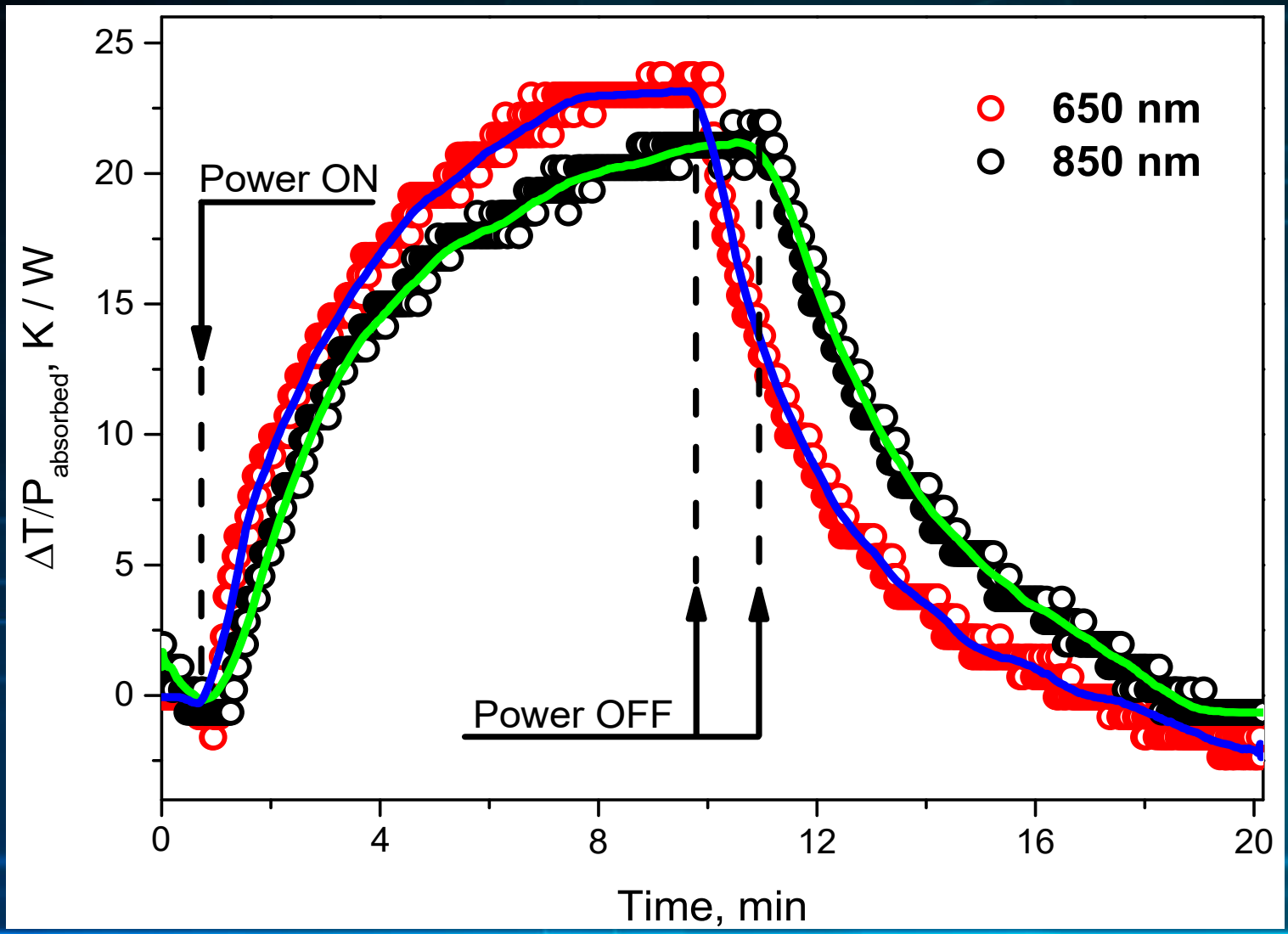
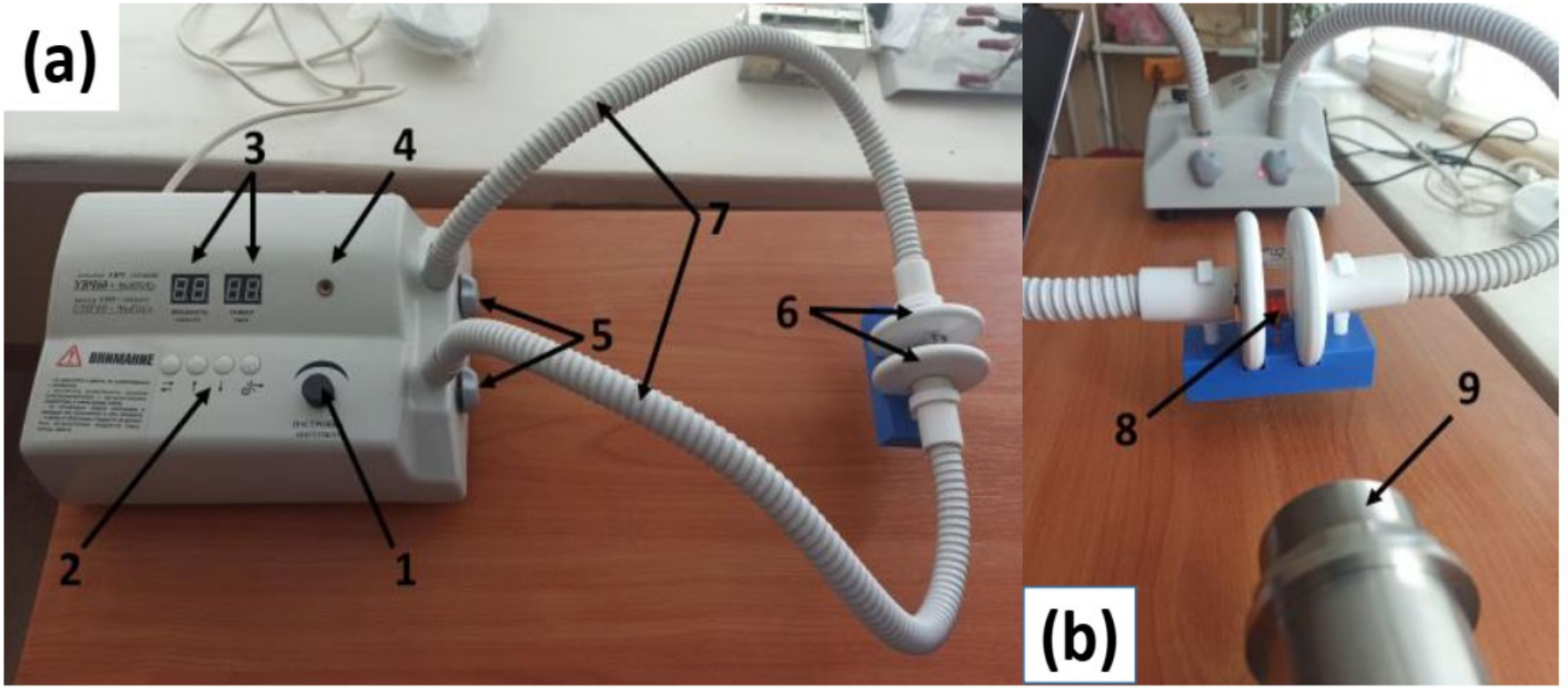


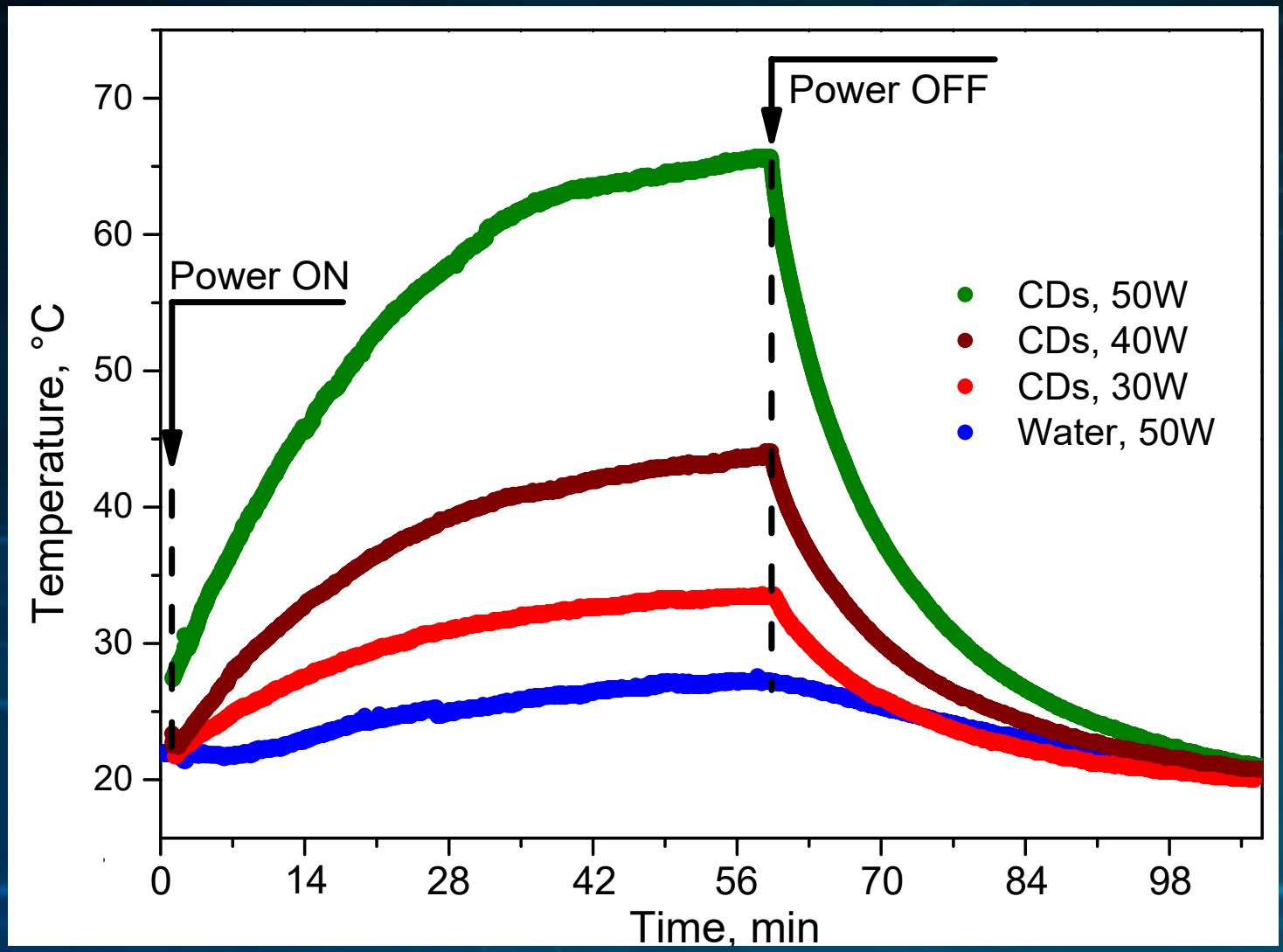
Photo-induced heating of CDs-based colloids



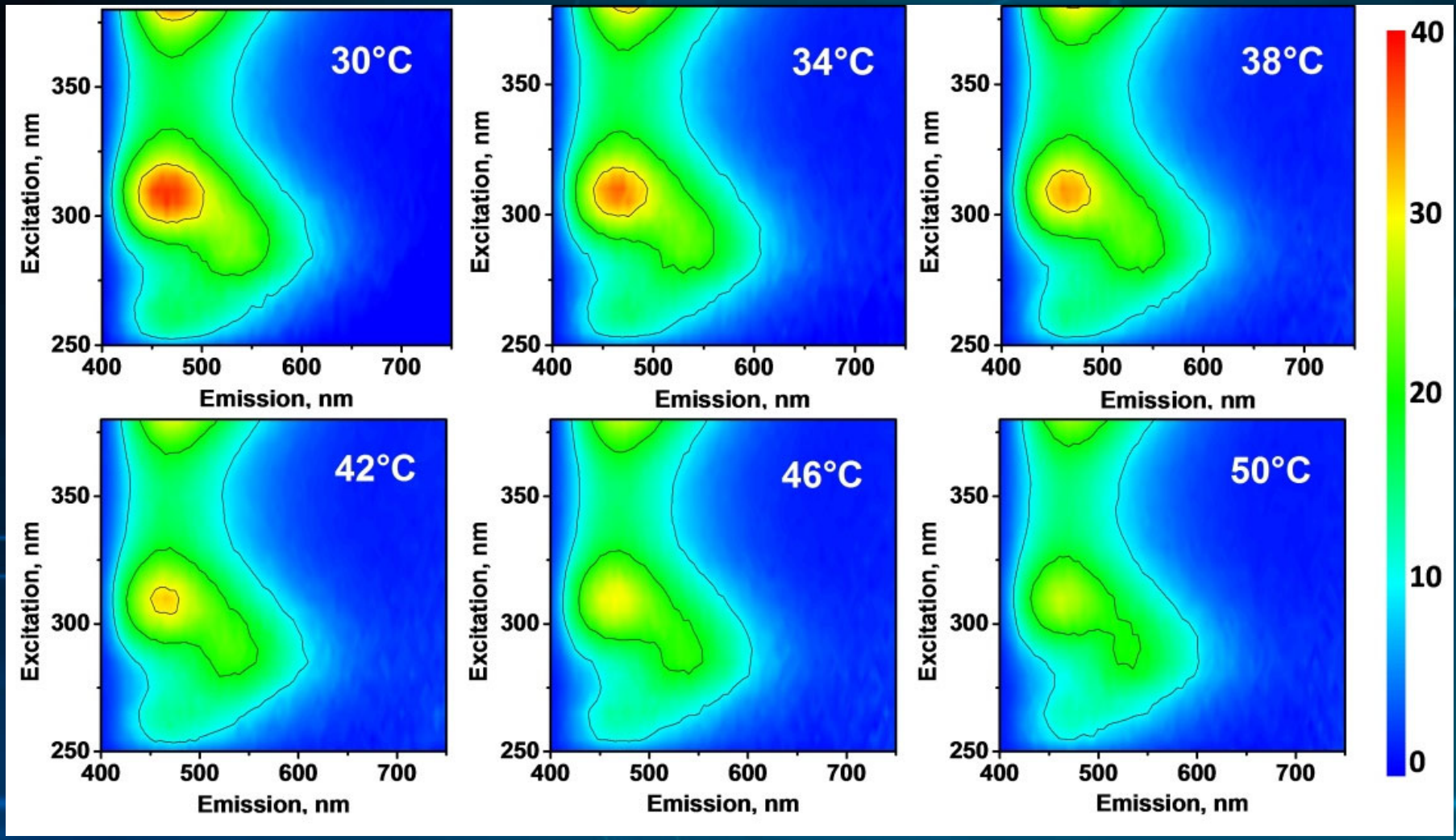
RF-induced heating of CDs-based colloids: set-up



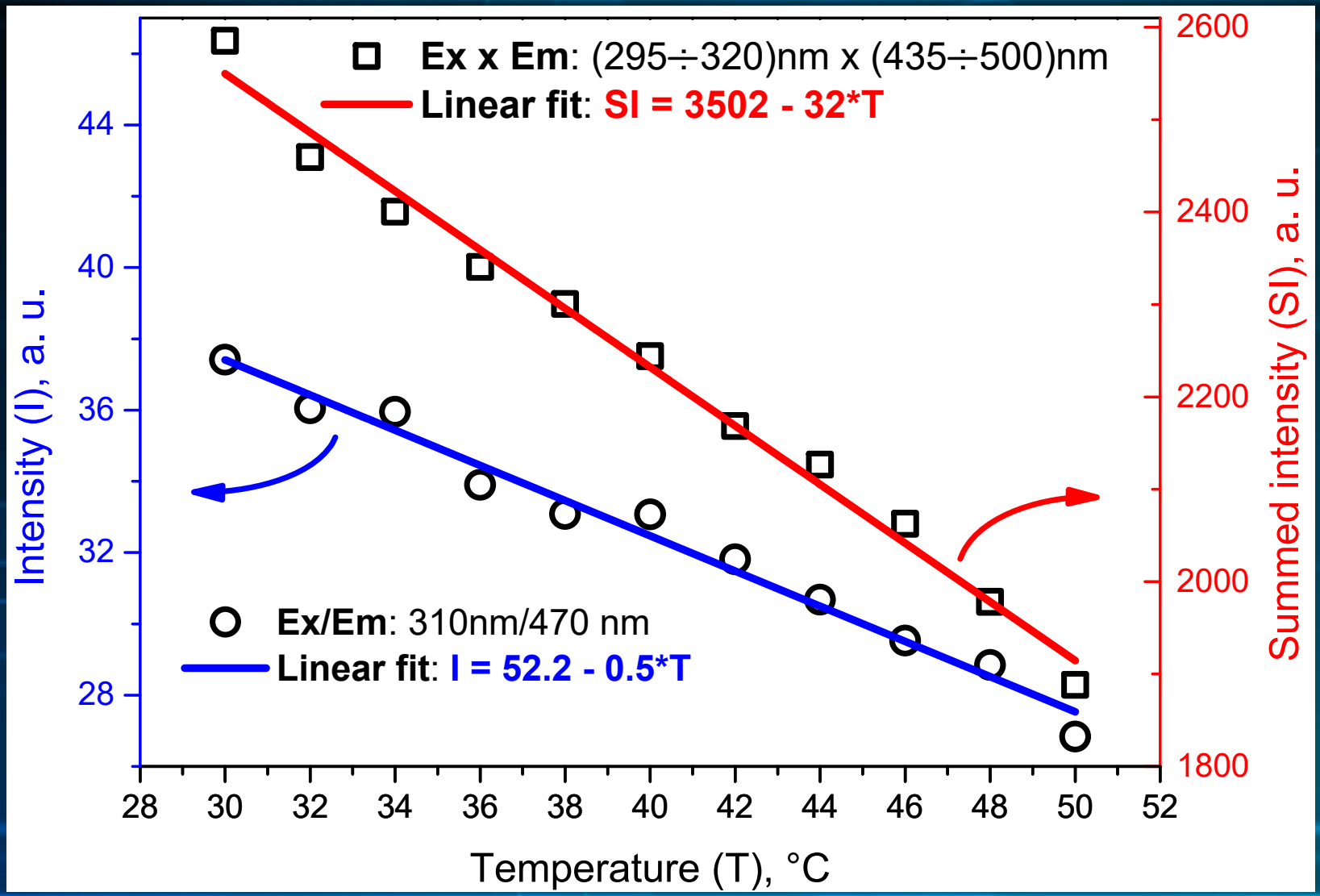
RF-induced heating of CDs-based colloids



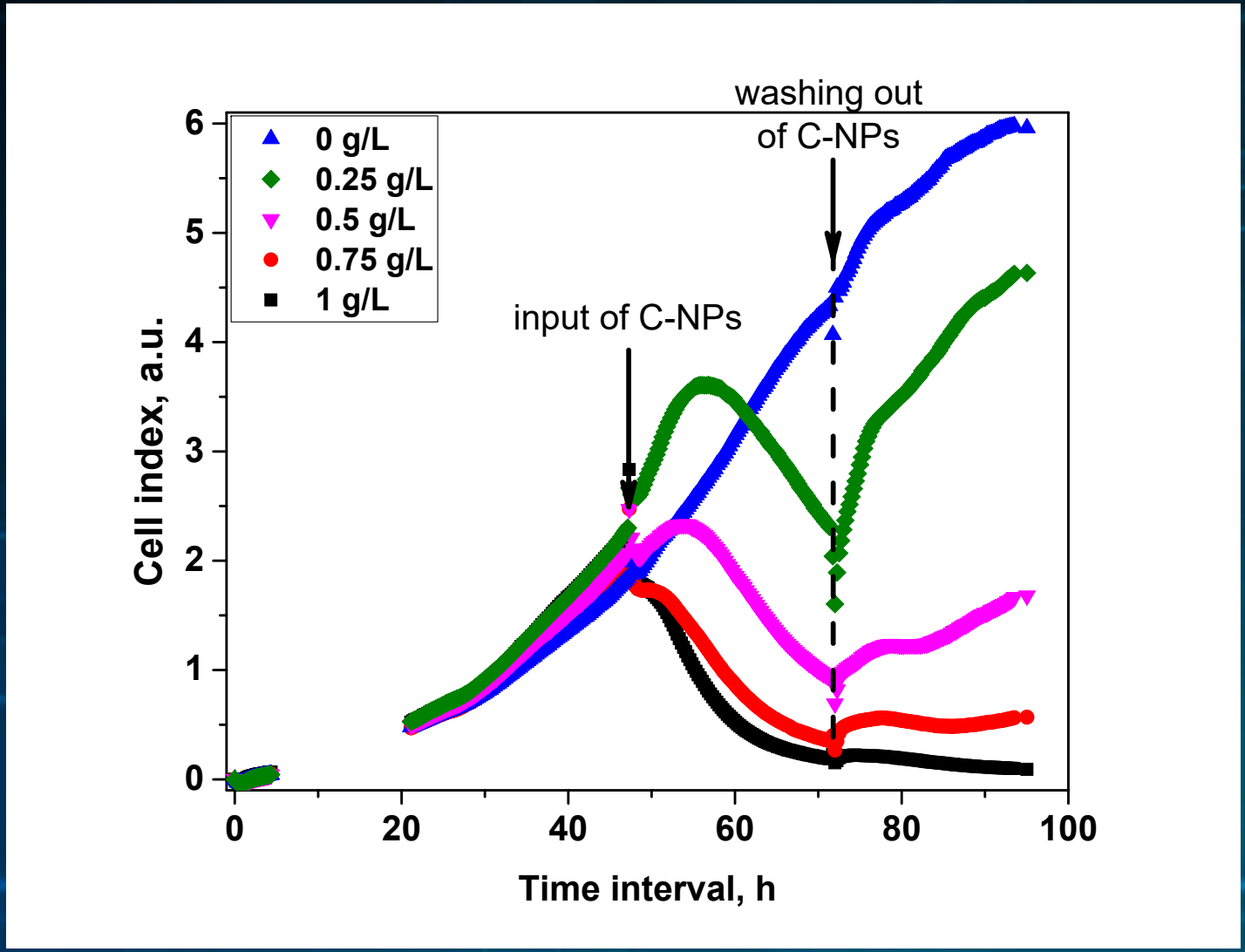
PL/PLE maps as function of temperature: colloids



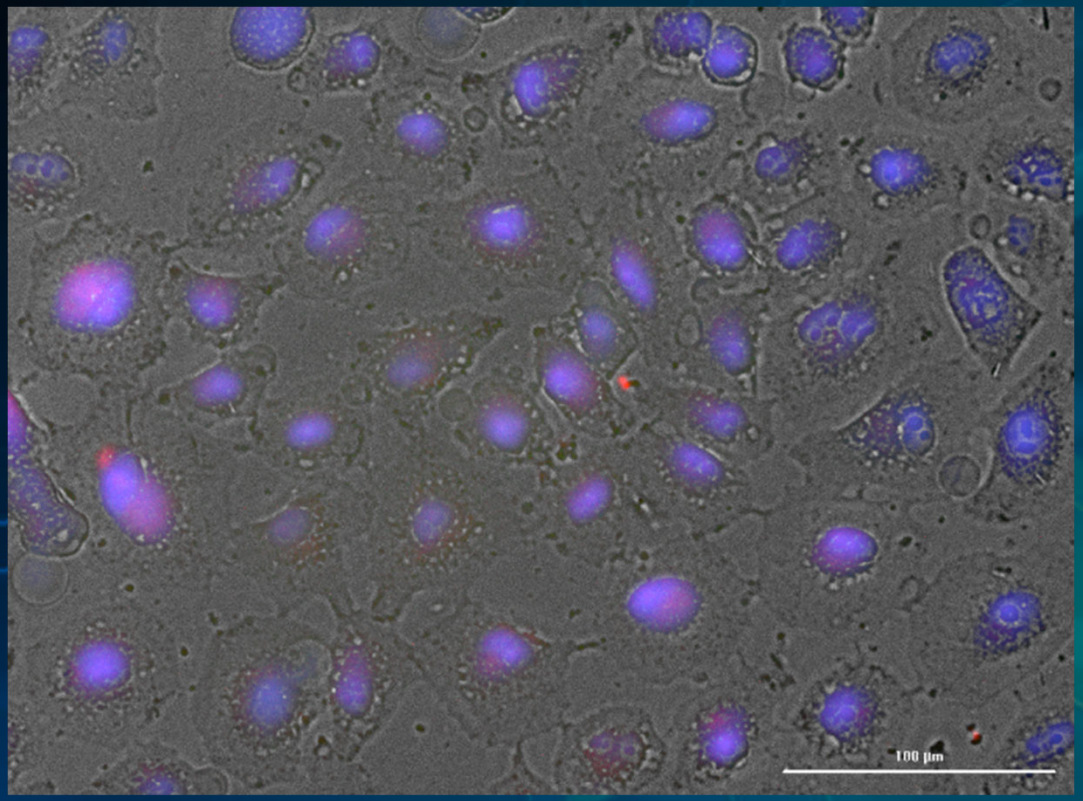
Temperature dependence of PL intensities: : colloids

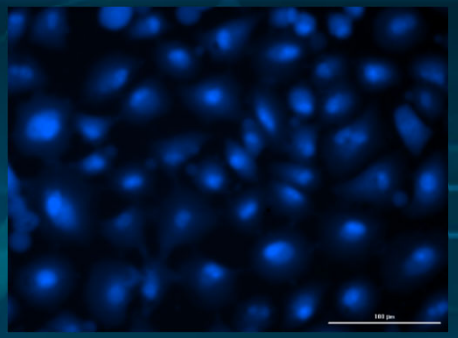


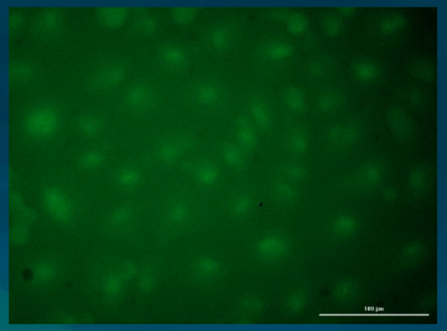
Cytotoxicity of CDs: in-vitro studies

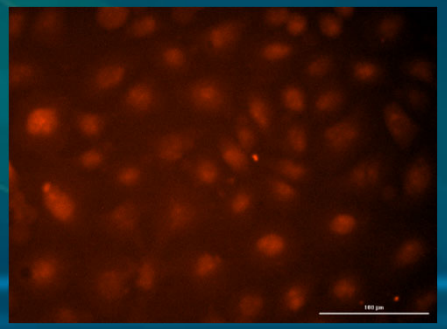


CDs for fluorescent labeling of cells









In-vivo photo-thermal treatment of tumors

-A highly metastatic strain of a tumor - **Lewis lung carcinoma**.

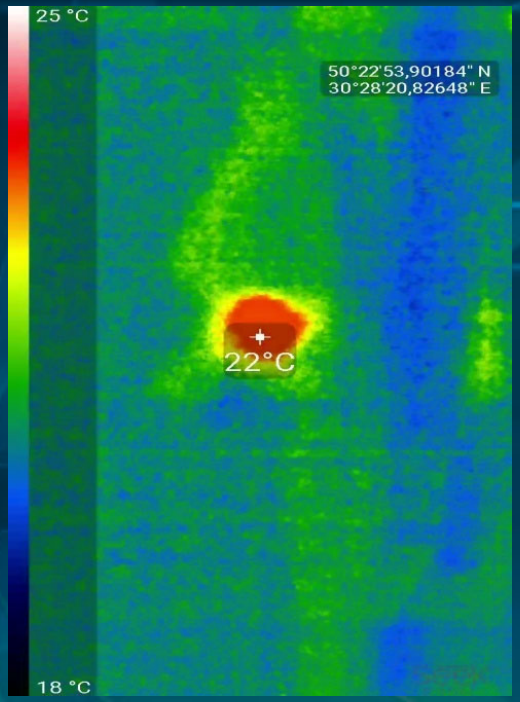
-Lewis lung cancer tumor transplantation was performed by intramuscular introduction of a primary tumor cell culture suspension (0.75×10^6 cells per animal) into the back right paw of the C57 / Black mouse line.

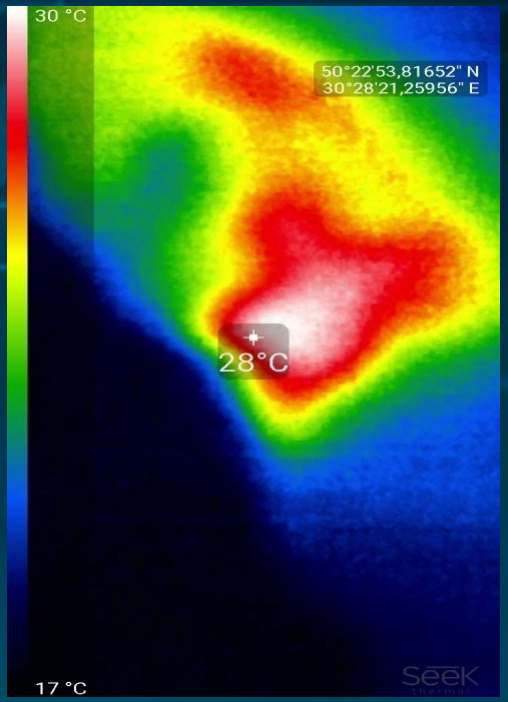
-Average animal weight at the beginning of the experiment was 19.4 ± 1.7 g.

-On 8-9 days after tumor introduction we started experiments with nanoparticles injection and laser irradiation.

-The injection of 100 µl solution with nanoparticles was performed into selected mouse tumor site. Saline was injected by the same way for control group.

In-vivo photo-thermal treatment of tumors: set-up





Mice irradiation:

-AlviPrague TL-500 laser

-the irradiation mode “532 nm (green) + 1064 nm (IR)”, + two light filters marked HC1, HC2 and HC3 .

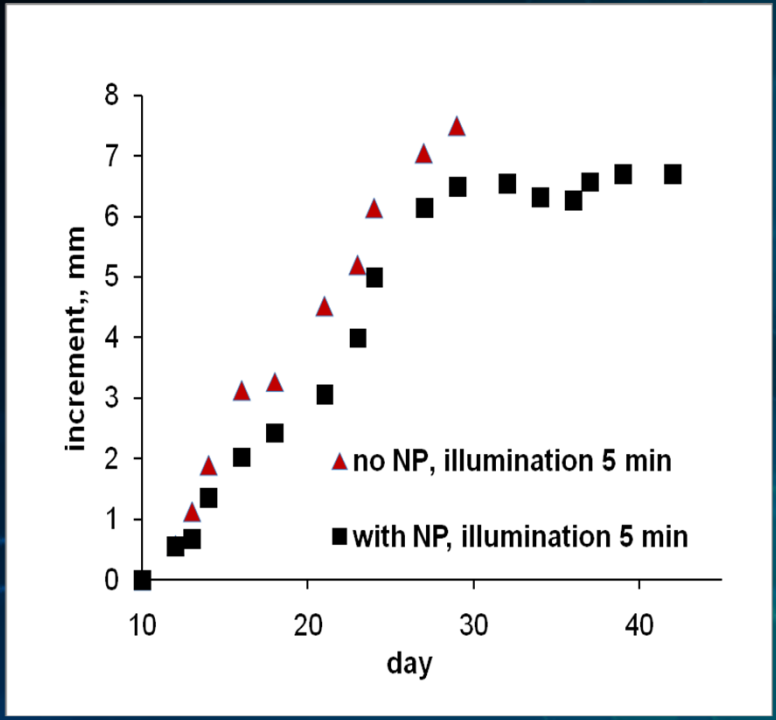
-The pulse repetition rate is 1 Hz.

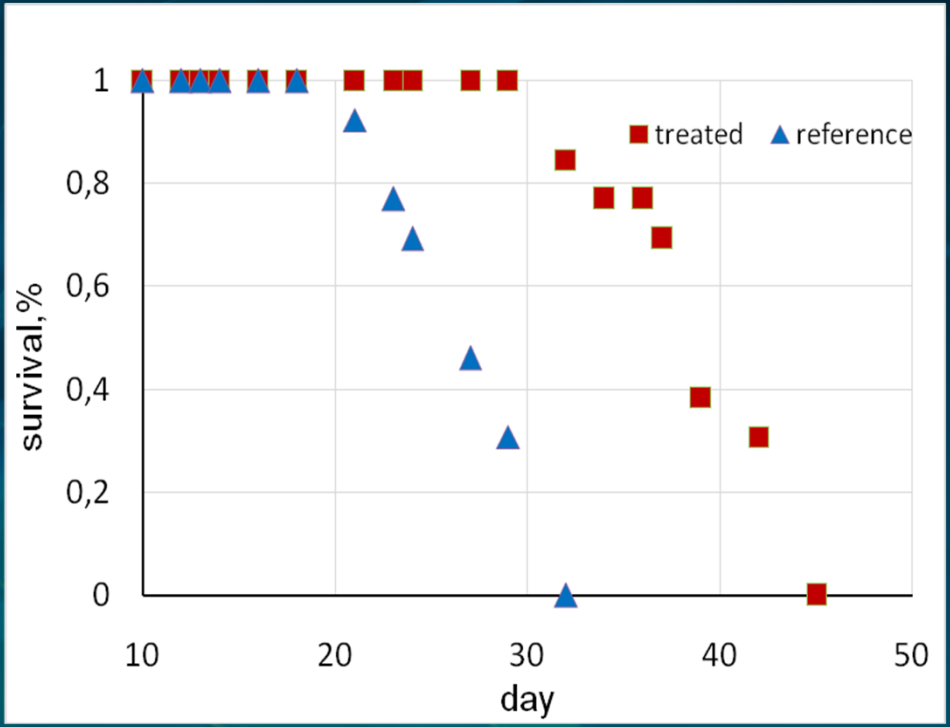
-The duration of each pulse is 3.5 ns,

-the beam diameter is (3 ± 1) mm.

- After the filters, the energy density was ~ 2.5 mJ / cm^2 (part of the “IR” wavelength is 90%).

In-vivo photo-thermal treatment of tumors





Mice survival for treated (NP+irradiation 5 and 10 min) and reference (without NP, with irradiation 5 and 10 min) mice.

Conclusions

- NIR and RF radiations interact efficiently with carbon nanodots
- Carbon dots at low concentrations are non toxic and are suitable for bio-imaging purposes
- Tepmperature dependence of carbon dots fluorescence can be used for estimation of local temperature
- Carbon dots are reliable nano-sensitizers to be used for photo- and RF-based therapy
- In-vivo experiments are to be continued…

Thank you for your attention !