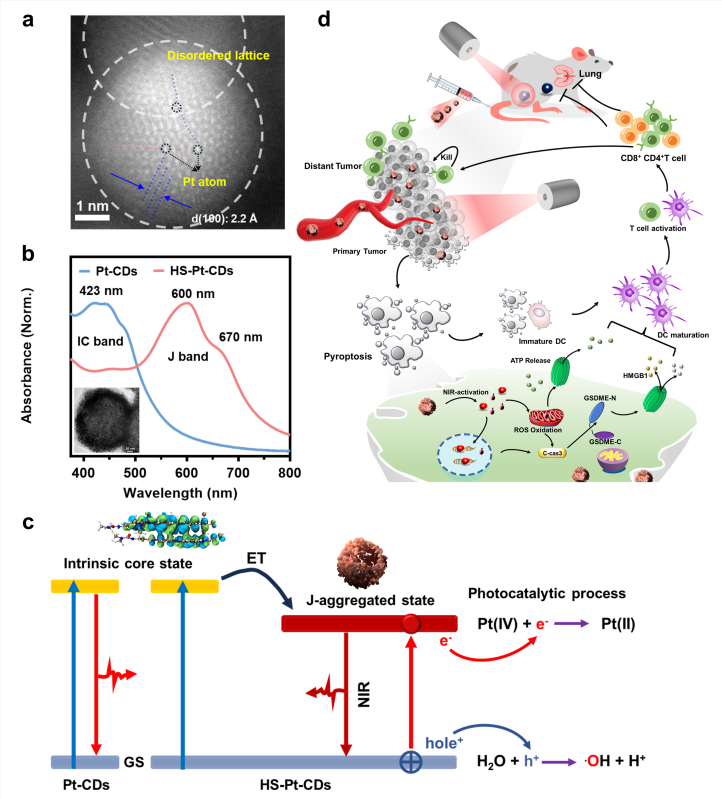
J-Type Supra-(Carbon Dots) for Near-Infrared Light-Triggered Pyroptosis

GA, UNITED STATES, May 7, 2025 /EINPresswire.com/ -- Deep-penetration light-triggered pyroptosis based on nanomedicine for tumor precision therapy still remains challenging. Towards this goal, Scientist in China reported a supramolecular engineering strategy to construct Pt(IV)-coordinated supra-(carbon dots) with NIR-activated photocatalytic capacity to trigger tumor pyroptosis, thereby evoking anti-tumor immune responses to suppress distant tumor and prevent cancer metastasis. The finding will open new avenues for precision phototherapy in future clinical oncology by supramolecular-mediated nanomedicine with deep-penetration light triggered pyroptosis.



J-Type Assembled Pt(IV)-Coordinated Carbon Dots for Near-Infrared Light-Triggered Pyroptosis.

Nanomedicine has garnered growing interest in emerging innovative technologies of cancer immunotherapy, which has steered the field of cancer treatment toward precision medicine. Pyroptosis, a form of highly immunogenic cells death (ICD), presents a potential avenue for the development of precision immunotherapy. Among the reported pyroptosis-induced agents, photocatalytic Pt(IV)-based nanomedicine, which can precisely release Pt(II) species and generate effective reactive oxygen species (ROS) under certain wavelength light irradiation, is of great interest for tumor phototherapy to prevent cancer immune evasion with minimal adverse effects and low drug resistance. Current platinum-based nanomedicines are limited by ultraviolet/visible light activation, restricting tissue penetration.

In a new paper published in Light: Science & Applications, a team of scientists, led by Professor Songnan Qu from Joint Key Laboratory of the Ministry of Education, Institute of Applied Physics and Materials Engineering, University of Macau, Taipa, Macau SAR, China, and co-workers have

developed a novel supramolecular engineering strategy to construct Pt(IV)-coordinated supra-(carbon dots) (HS-Pt-CDs) with NIR-activated photocatalytic capacity to trigger tumor pyroptosis for precision tumor phototherapy. This study bridges nanomedicine and immunotherapy, addressing key challenges in metastatic cancer treatment.

By integrating supramolecular engineering, defect-driven J-aggregation, and pyroptosis induction, this work pioneers a new frontier in photocatalyst immunotherapy. The HS-Pt-CDs platform exemplifies how nanotechnology can overcome biological barriers, offering hope for metastatic and treatment-resistant cancers. These scientists summarize the principle of their nanomedicine:

"We engineered HS-Pt-CDs using a supramolecular strategy where Pt(IV) coordination induces lattice distortions in carbon dots (CDs), forming defect-driven 'bowl-like' structures. These self-assemble into J-type slip-stacked aggregates under ultrasound, achieving a 240 nm red-shift in absorption (423 nm□670 nm). This enables NIR activation, critical for deep-tissue penetration and clinical relevance."

"Our HS-Pt-CDs act as a 'Trojan horse'—harmless until activated by NIR light, then unleashing pyroptosis and immune activation. This synergy between localized destruction and systemic immunity represents a paradigm shift in precision oncology." They added.

"The presented strategy can be used to avoids surgical invasiveness or recognize residual cancer cells, reducing recurrence risk. Compatibility with existing immunotherapies (e.g., checkpoint inhibitors) could enhance efficacy. This breakthrough could open a new venue for future localized tumor ablation, long-term immune memory, and clinical potential." The scientists forecast.

References
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Lucy Wang
BioDesign Research
email us here