

Intrinsically Radiolabeled Nanoparticles: An Emerging Paradigm

Weibo Cai, PhD

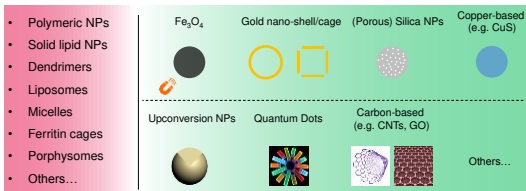
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Nanoplatforms for Cancer Theranostics

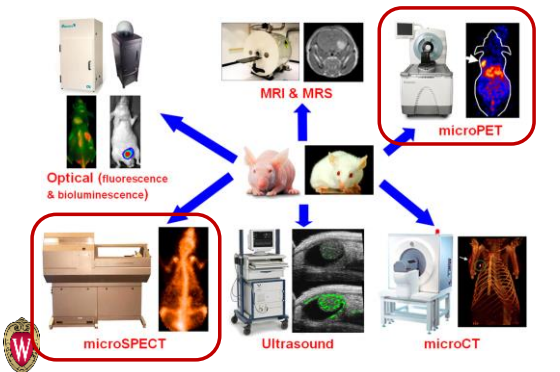


- Different nanoplatforms (organic and inorganic)
- Step-by-step surface modifications
- Potential to revolutionize diagnosis and treatment

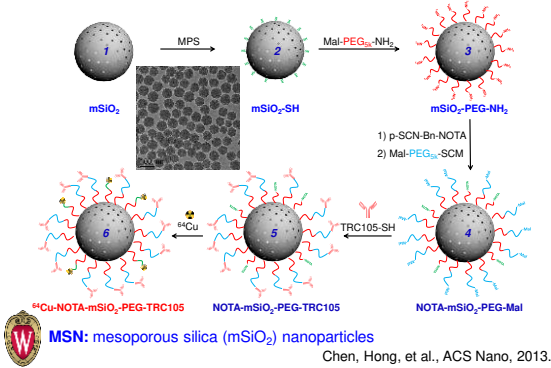


Chen et al., J Nucl Med, 2014.

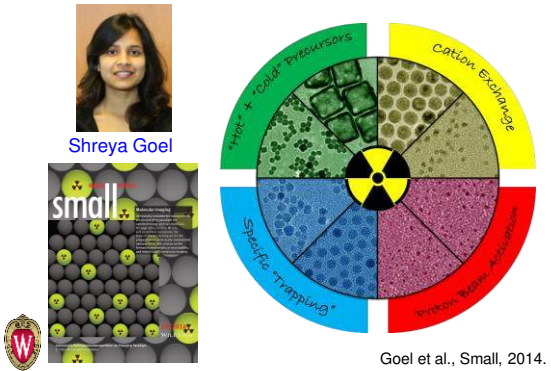
Small Animal Molecular Imaging



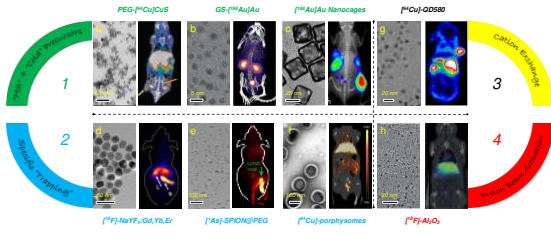
Functionalization of MSN for Theranostics



Intrinsically Radiolabeled Nanoparticles



Intrinsically Radiolabeled Nanoparticles



- Chelator-free (or no additional step) radiolabeling
 - Takes advantages of the physical/chemical properties of rationally selected nanoparticles for radiolabeling
 - Could offer an easier, faster and more specific radiolabeling possibility
- Goel et al., Small, 2014.

Commonly Used Strategies

Hot-plus-Cold Precursors

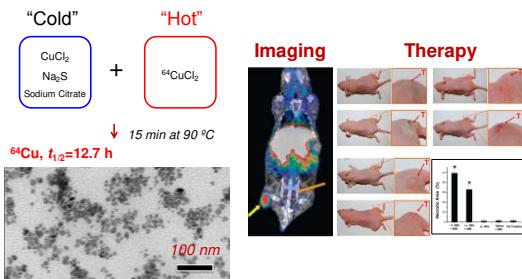
Cation Exchange

Proton Beam Activation

Specific Trapping

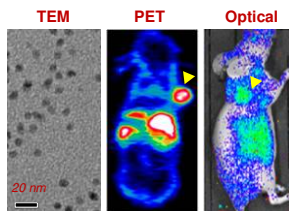


Hot-plus-Cold Precursors: [^{64}Cu]CuS



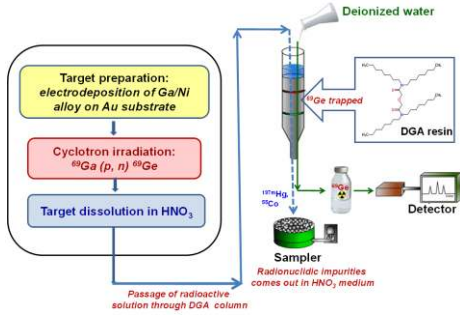
Zhou et al., J Am Chem Soc, 2010.

Cation Exchange: [^{64}Cu]QD580



Sun et al., J Am Chem Soc, 2014.

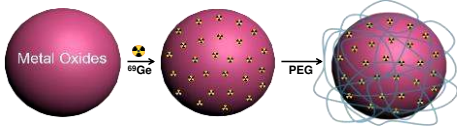
⁶⁹Ge ($t_{1/2} = 39.05$ h)



Hard to label due to existence of ⁶⁹Ge as complex ions in aqueous medium

Chakravarty, Valdovinos, Chen et al., Adv Mater, 2014.

Labeling Inspired by ⁶⁸Ge/⁶⁸Ga Generators

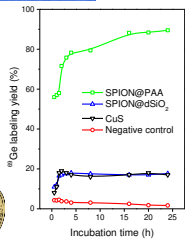


Chakravarty, Valdovinos, Chen et al., Adv Mater, 2014.

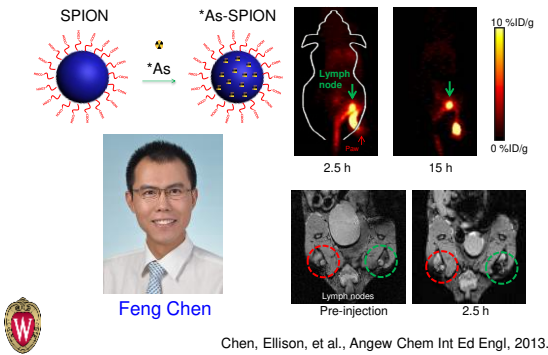
PET/MRI in Normal BALB/c Mice



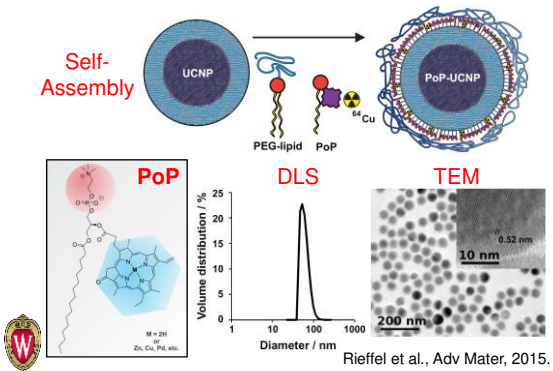
Rubel Chakravarty



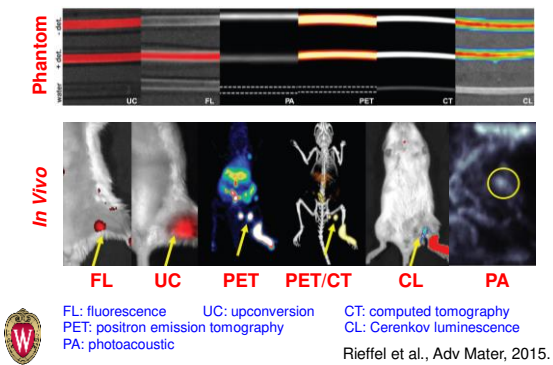
Chelator-Free Synthesis of PET/MRI Agent



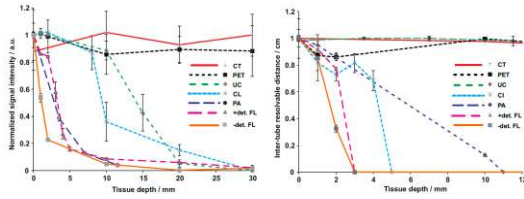
Hexamodal Imaging with Nanoparticles



Hexamodal Imaging with Nanoparticles



Direct Comparison of Imaging Techniques

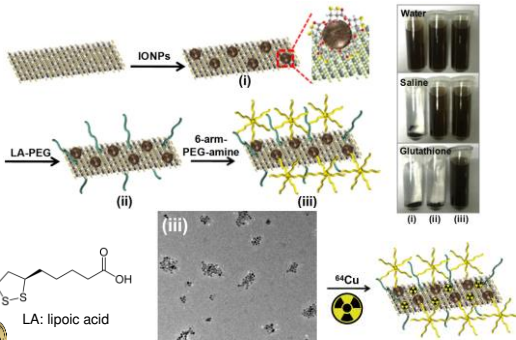


- Self-assembly of 2 active imaging components (PoP & UCNPs)
- FL (and PA) provided unique information on the **self-assembly status**
- PET and CT provided the **deepest imaging capabilities**
- CL and UC imaging was effective for imaging at intermediate depths, significantly better than FL
- Such simple yet higher-order multimodal imaging agents can facilitate the development of integrated imaging systems



Rieffel et al., Adv Mater, 2015.

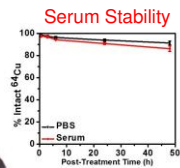
Iron Oxide Decorated MoS₂ Nanosheets



Prof. Zhuang Liu

Liu et al., ACS Nano, 2015.

Non-Invasive Quantitative PET Imaging

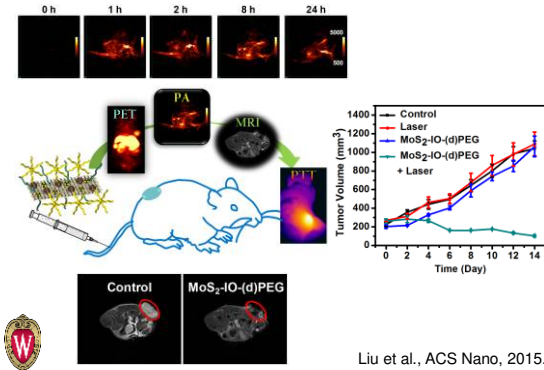


Sixiang Shi

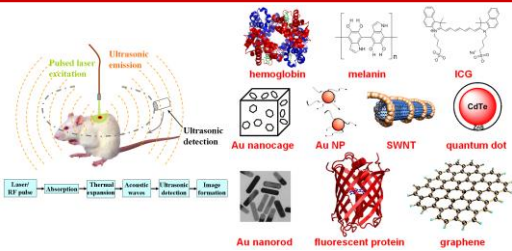


Liu et al., ACS Nano, 2015.

Multimodal Image-Guided PTT

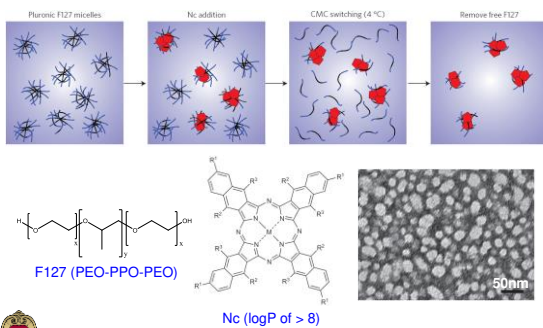


Photoacoustic Tomography (PAT)



- Deeper signal penetration than other optical methods
- Inherently real-time imaging, suitable for imaging dynamic processes without sacrificing spatial resolution
- In the USA alone, [digestive diseases](#) are implicated in upwards of 100 million ambulatory care visits annually

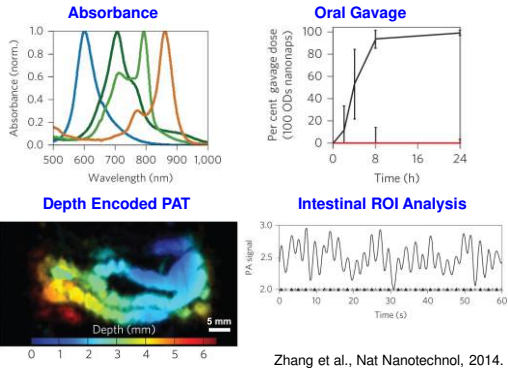
Kinetically Frozen Micellar Naphthalocyanines



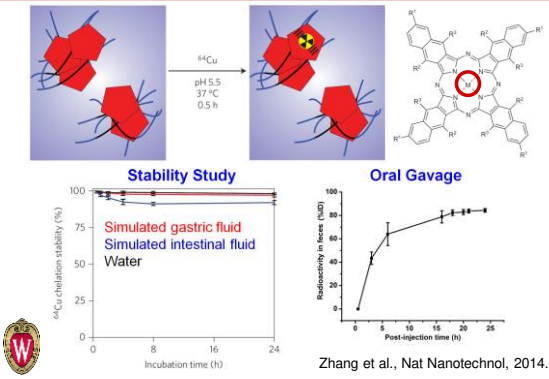
Prof. Jonathan F. Lovell
University at Buffalo

Zhang et al., Nat Nanotechnol, 2014.

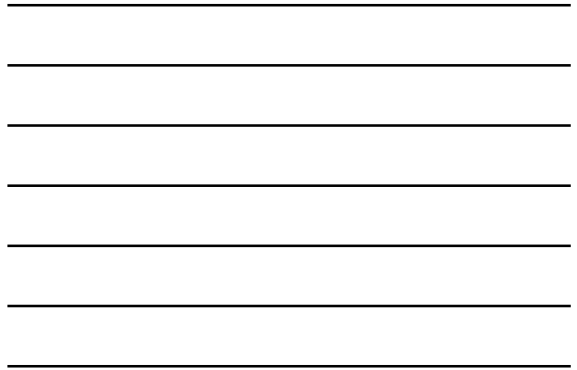
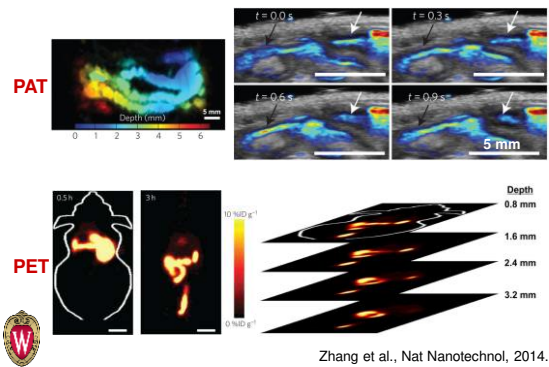
Multispectral Nanonaps & PAT Imaging



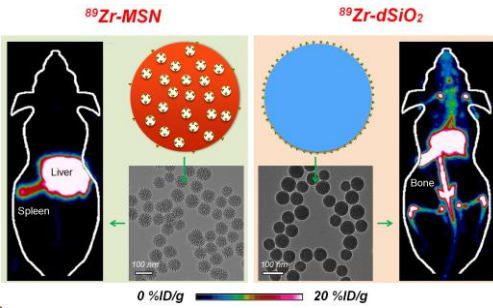
Seamless ⁶⁴Cu-Labeling



Dual-Modality In Vivo PAT/PET Imaging



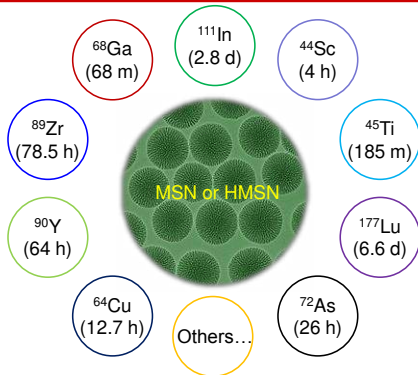
Chelator-Free ⁸⁹Zr-Labeling of MSN



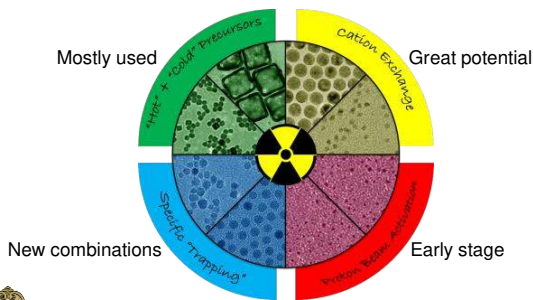
MSN: mesoporous silica (mSiO₂) nanoparticles

Chen, Goel, et al., ACS Nano, Revision.

MSN: A Versatile Radiolabeling Platform



Intrinsically Radiolabeled Nanoparticles



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- Prof. Jonathan F. Lovell (U Buffalo)

