List of 10 best paper of *Pritiranjan Mondal* presented here for *Sun Pharma Science Foundation research fellowship*

1. **Paper title:** “All-in-one” ink for light-based 4D printing of conducting, tough, anti-freezing, and cytocompatible hydrogels

Authors: Pritiranjan Mondal, Arkodip Mandal, Kaushik Chatterjee

Publication date: 9/7/2024

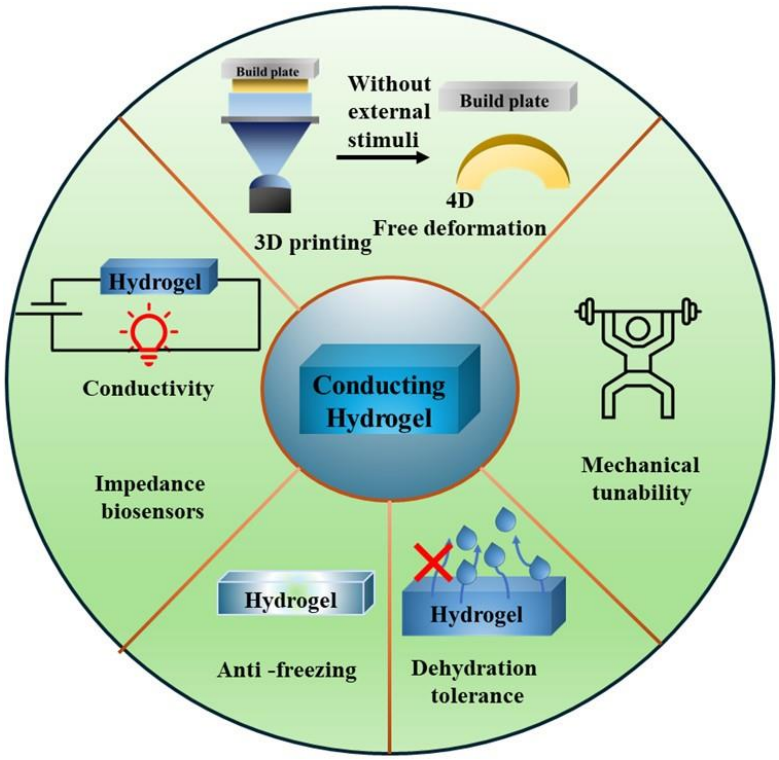
Journal: Chemical Engineering Journal

Link: https://doi.org/10.1016/j.cej.2024.153883

Highlight the importance discoveries:

High-performance hydrogel-based electronic devices require conducting hydrogels. Conducting hydrogels that are stretchable, soft, and biocompatible are in much demand to fabricate human-machine interfaces, wearable devices, soft robotics, and many other applications. In this study, we established a new generation polymeric formulation to prepare hydrogels by digital light processing (DLP)-based three-dimensional (3D) printing technology with visible light that are anti-freezing, electrically conductive, tough, stretchable, and non-toxic. The printed conducting hydrogels have exceptional water-holding capability at atmospheric conditions and tolerance to freezing over a wide range of temperatures from −80 to 45°C. The inks are amenable to the manufacturing of four-dimensional (4D)-printed hydrogels that can elicit pre-programmed structural deformations. This work presents polymeric formulations for potentially designing ultrafast programmable electronic devices with printed hydrogel electronics in various biomedical applications, soft robotics, biosensors, flexible electronics, human-machine interfaces, and health monitors for use under extreme environmental conditions.

Keywords: Conducting hydrogel; 4D Printing; Anti-freezing; Dehydration tolerance; Biocompatible, Tissue engineering, soft robotics, Biomedical applications.



TOC: Given the attractive combination of attractive properties, these 3D/4D-printed conducting hydrogels are promising candidates for application across diverse domains, particularly bio-electronic applications in healthcare and other fields.

2. **Paper title:** Multi-biofunctional Self-healing Adhesive Injectable Nanocomposite Polysaccharide Hydrogel

Authors: Pritiranjan Mondal, Kaushik Chatterjee

Publication date: 11/7/2024

Journal: Biomacromolecules

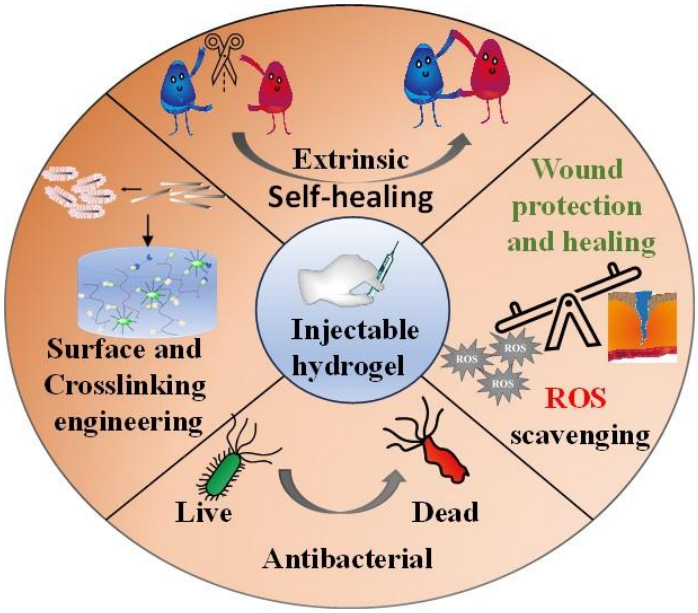
Link: https://pubs.acs.org/doi/10.1021/acs.biomac.4c00016.

Highlight the importance discoveries:

Injectable hydrogels with good antimicrobial and antioxidant properties, self-healing characteristics, suitable mechanical properties, and therapeutic effects have great practical significance for developing treatments for pressing healthcare challenges. Herein, we have designed a novel, self-healing injectable hydrogel composite incorporating crosslinked biofunctional nanomaterials by mixing alginate aldehyde (Ox-Alg), quaternized chitosan (QCS), adipic acid dihydrazide (ADH), and copper oxide nanosheets surface functionalized with folic acid as the bioligand (F-CuO). Gelation was achieved under physiological conditions via the dynamic Schiff base crosslinking mechanism. The developed

nanocomposite injectable hydrogel demonstrated the fast self-healing ability essential to bear deformation and outstanding adhesive and antibacterial properties along with ROS scavenging ability. Furthermore, the optimized formulation of our F-CuO-embedded injectable hydrogel exhibited excellent cytocompatibility, blood compatibility, and in vitro wound healing performance. Taken together, the F-CuO nanosheet crosslinked injectable hydrogel composite presented herein offers a promising candidate biomaterial with multifunctional properties to develop solutions for addressing clinical challenges.

Keywords: CuO; Injectable hydrogel; Self-healing; Adhesive; Antibacterial; ROS scavenging



TOC: Polysaccharide based injectable self-healing hydrogel with embedding bioligand functionalized nanomaterials offers an attractive combination of outstanding antibacterial properties for a minimally invasive delivery platform.

3. **Paper title:** Bi-Directional Shape Morphing in 4D-Bioprinted Hydrogels on a Single Stimulation

Authors: Pritiranjan Mondal, Arkodip Mandal, Kaushik Chatterjee

Publication date: 27/07/2023

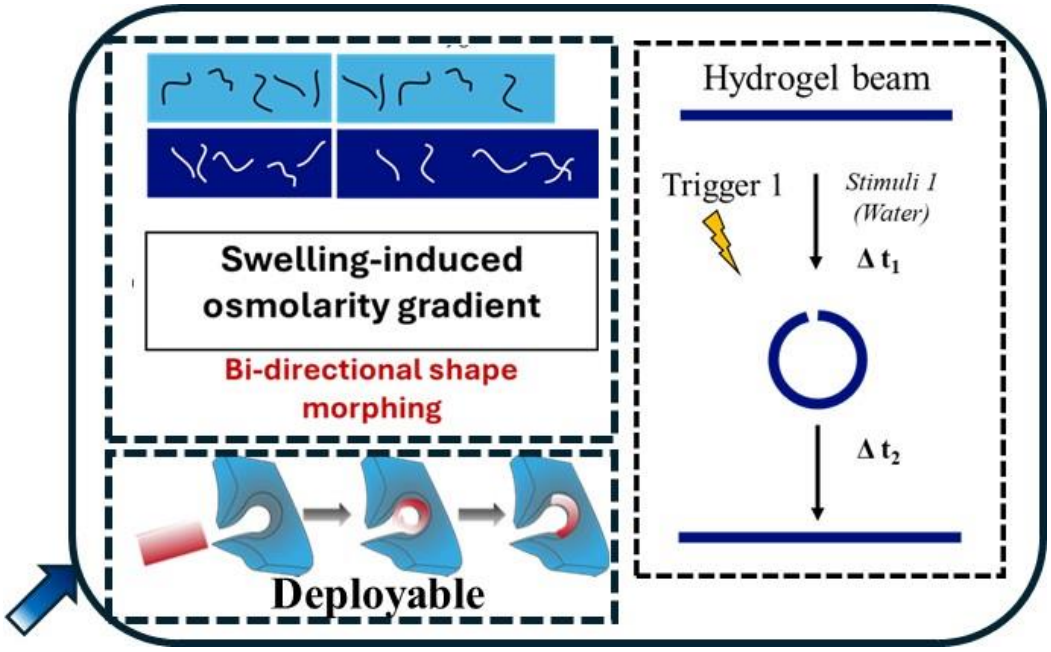
Journal: Advanced Materials Technologies

Link: https://doi.org/10.1002/admt.202300894

Highlight the importance discoveries:

In this study, we introduce a generalizable four-dimensional (4D) bioprinting technique utilizing graded semi-interpenetrating network (IPN) hydrogels with versatile ink design, which exhibit rapid, sequential shape-morphing transformations in two opposite directions on a single stimulation (immersion in water). The bi-directional shape morphing behavior is governed by the sequential activation of two distinct actuation mechanisms, namely, anisotropic water uptake due to photocrosslinking gradient and subsequent temporal water redistribution as a consequence of differential swelling-induced osmolarity gradient. We demonstrate that the spatiotemporal characteristics of these bi-directional shape-morphing hydrogels can be precisely programmed according to desired part specifications by rationally designing dual-component hydrogel systems based on a mechanistic understanding of the underlying phenomena. Additionally, we provide a proof-of-concept demonstration where we leverage the bi-directional, shape-morphing behavior for the design of soft, deployable hydrogel devices. Lastly, we propose a systematic guideline facilitating the selection of the second hydrogel component for tuning the extent and pace of shape changes. Owing to their excellent biocompatibility and mild enabling conditions, these hydrogels stand to transform our capacity to precisely design soft, deployable devices for the delivery of therapeutic agents in a minimally invasive manner inside the human body, among other potential applications.

Keywords: Bioprinting; 4D printing; Deployable device; Shape-morphing hydrogels; Biomaterials



TOC: The developed actuation techniques governing the shape transformations, wherein the outcome of the first phase of shape transformation induces the subsequent transformation(s), can be extended to other material systems for the development of dynamically reconfigurable architectures with tunable functionality for applications in soft robotics, tissue engineering, drug delivery, minimally invasive devices, and beyond.

4. **Paper title:** Injectable and self-healing double network polysaccharide hydrogel as a minimally-invasive delivery platform

Authors: Pritiranjan Mondal, Kaushik Chatterjee

Publication date: 07/05/2022

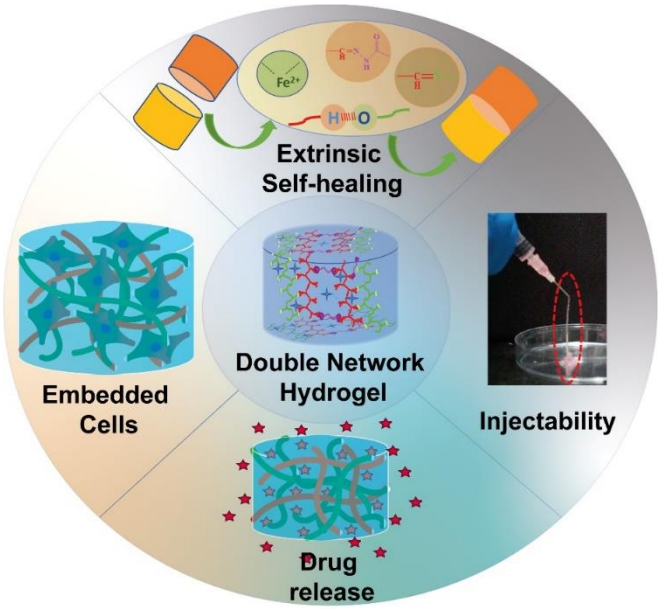
Journal: Carbohydrate Polymers

Link: https://doi.org/10.1016/j.carbpol.2022.119585

Highlight the importance discoveries:

Injectable hydrogels exhibiting self-healing ability are promising carriers for controlled and sustained delivery in a minimally-invasive format for biomedical applications. In this work, we designed a polysaccharide-based double network hydrogel by mixing solutions of aldehyde-alginate (aAlg) and acrylic acid-chitosan (aCS) in the presence of adipic acid dihydrazide and $FeCl_2$ that resulted in dual crosslinking mediated by Schiff base and ionic interactions. The hydrogel exhibited excellent thixotropic and self-healing properties with a high compressive fracture strength of ≈48 kPa. Encapsulated cells were viable within the hydrogel and after their release from the degraded gel. The controlled release of Doxorubicin and Ciprofloxacin from the hydrogels established the gel as a delivery platform. The released drugs were effective in killing cancer cells or arresting the growth of both bacteria. This work presents a self-healing and injectable degradable hydrogel that may be used as a minimally-invasive platform for the delivery of drugs and cells.

Keywords: injectable hydrogel; self-healing; biomaterials; drug delivery



TOC: The degradable and injectable hydrogels were developed here could find promising clinical applications for encapsulation and release of cells and drugs.

5. **Paper title:** Light-based 3D bioprinting of bone tissue scaffolds with tunable mechanical properties and architecture from photocurable silk fibroin

Authors: Monika Rajput, Pritiranjan Mondal, Parul Yadav, Kaushik Chatterjee

Publication date: 20/01/2022

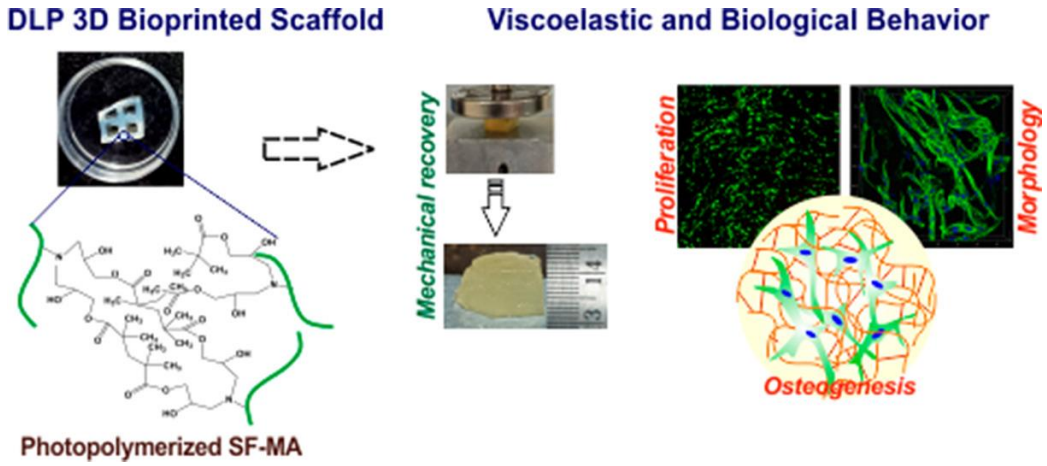
Journal: International Journal of Biological Macromolecules

Link: https://doi.org/10.1016/j.ijbiomac.2022.01.081

Highlight the importance discoveries:

Three-dimensional (3D) bioprinting based on digital light processing (DLP) offers unique opportunities to prepare scaffolds that mimic the architecture and biomechanical properties of human tissues. Limited availability of biocompatible and biodegradable bioinks amenable for DLP-bioprinting is an impediment in this field. In this study presents a bioink prepared from silk fibroin (SF) tailored for DLP bioprinting. Photocurable methacrylated-SF (SF-MA) was synthesized with 67.3% of methacrylation. Physical characterization of rheological and mechanical properties revealed that the 3D printed hydrogels of SF-MA (spanning from 10 to 25 wt%) exhibit bone tissue-like viscoelastic behavior and compressive modulus ranging from ≈12 kPa to ≈96 kPa. The gels exhibited favorable degradation (≈48 to 91% in 21 days). This SF-MA bioink afforded the printing of complex structures, with high precision. Pre-osteoblasts were successfully encapsulated in 3D bioprinted SF-MA hydrogels with high viability. 15% SF-MA DLP bioprinted hydrogels efficiently supported cell proliferation with favorable cell morphology and cytoskeletal organization. A progressive increase in cell-mediated calcium deposition up to 14 days confirmed the ability of the gels to drive osteogenesis, which was further augmented by soluble induction factors. This work demonstrates the potential of silk fibroin-derived bioinks for DLP-based 3D bioprinting of scaffolds for tissue engineering.

Keywords: Silk fibroin, Digital light processing, Hydrogels, Osteogenesis, Bone tissue engineering



TOC: This study presents SF-MA as a viable bioink for DLP-based 3D bioprinting to prepare tissue scaffolds that can mimic the mechanical and architectural features of human tissues with excellent bioactivity.

6. **Paper title:** Digital light processing-based 3D bioprinting of κ-carrageenan hydrogels for engineering cell-loaded tissue scaffolds

Authors: Sushma Kumari, Pritiranjan Mondal, Kaushik Chatterjee

Publication date: 21/04/2022

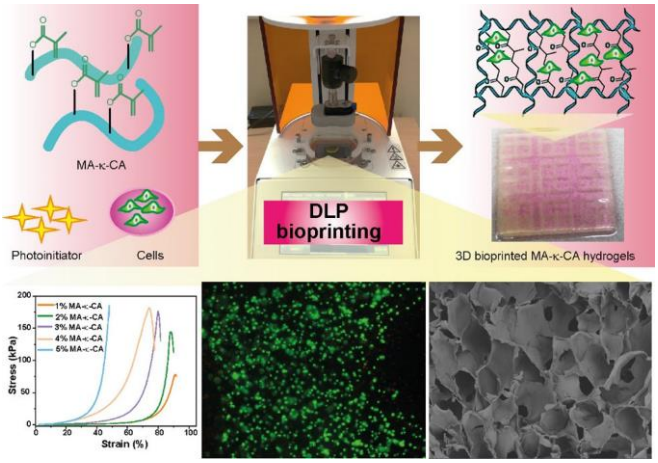
Journal: Carbohydrate Polymers

Link: https://doi.org/10.1016/j.carbpol.2022.119508

Highlight the importance discoveries:

The demand to regenerate biological tissues and organs in patients as an alternative to transplants has motivated the tissue engineering field. Digital light processing (DLP)-based three-dimensional (3D) bioprinting technology enables the rapid fabrication of complex 3D cell-laden scaffolds for tissue engineering applications. In this study, we demonstrate the outstanding printability of photocurable methacrylate-κ-carrageenan (MA-κ-CA) using DLP 3D printing. 3D printed hydrogels with varying concentrations (1–5% w/v) of MA-κ-CA were thoroughly characterized for their swelling, degradation, mechanical, and rheological properties, and suitability for bioprinting with living cells. Viscosity and shear thinning behavior of MA-κ-CA faithfully recapitulate the biomechanical properties of soft human tissues. Encapsulated NIH-3T3 cells show high viability and good proliferation over several days. Furthermore, highly complex 3D hydrogel scaffolds of MA-κ-CA were printed to recapitulate the biological complexity of tissues and organs. This work presents a polysaccharide bioink for preparing tissue scaffolds by DLP 3D bioprinting.

Keywords: Digital light processing, Carbohydrates, Hydrogels, 3D bioprinting, Tissue engineering



TOC: The photopolymerizable bioink were developed here offers opportunities for bioprinting of a variety of soft tissues that can faithfully mimic the biomechanical properties and architecture of the native tissue.

7. **Paper title:** Visible Light-based 3D Bioprinted Composite Scaffolds of κ-Carrageenan for Bone Tissue Engineering Applications

Authors: Sushma Kumari, Pritiranjan Mondal, Suhela Tyeb, Kaushik Chatterjee

Publication date: 18/09/2023

Journal: Journal of Materials Chemistry B

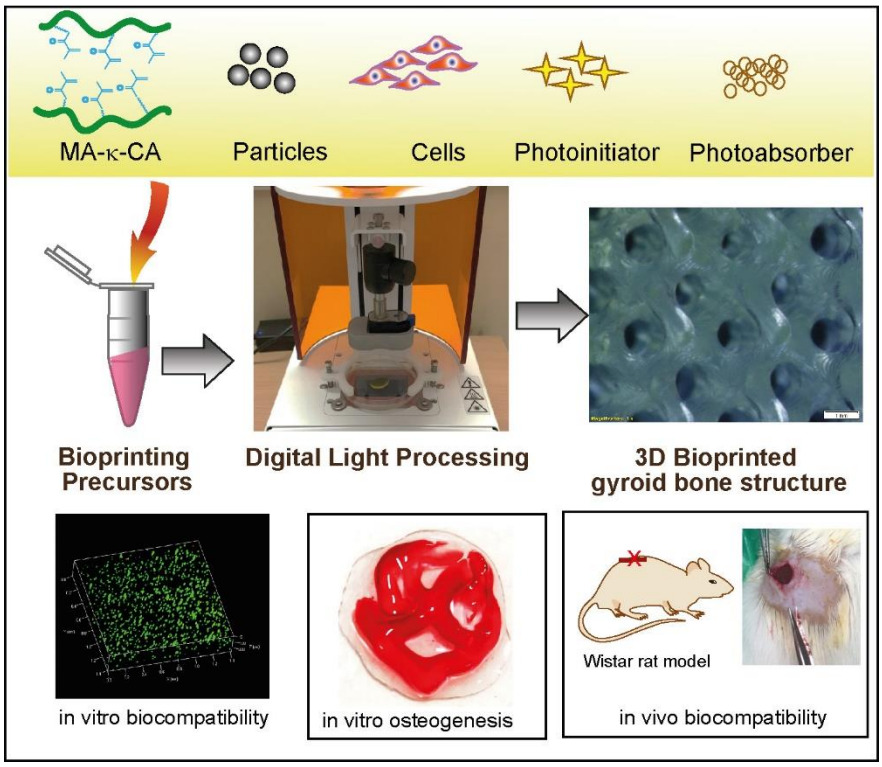
Link: https://doi.org/10.1039/D3TB02179C

Highlight the importance discoveries:

Three-dimensional (3D) printing of bone scaffolds using digital light processing (DLP) bioprinting technology empowers the treatment of patients suffering from bone disorders and defects through the fabrication of cell-laden patient-specific scaffolds. Here, we demonstrate the visible-light-induced photo-crosslinking of methacrylate-κ-carrageenan (MA-κ-CA) mixed with bioactive silica nanoparticles (BSNPs) to fabricate 3D composite hydrogels using digital light processing (DLP) printing. The 3D printing of complex bone structures, such as the gyroid, was demonstrated with high precision and resolution. DLP-printed 3D composite hydrogels of MA-κ-CA-BSNP were prepared and systematically assessed for their macroporous structure, swelling, and degradation characteristics. The viscosity, rheological, and mechanical properties were also investigated for the influence of nanoparticle incorporation in the MA-κ-CA hydrogels. The in vitro study performed with MC3T3-E1 pre-osteoblast-laden scaffolds of MA-κ-CA-BSNP revealed high cell viability, no cytotoxicity, and proliferation over 21 days with markedly enhanced osteogenic differentiation compared to neat polymeric scaffolds. Furthermore, no inflammation was observed in the 21-day study involving the in vivo examination of DLP-printed 3D composite scaffolds in a Wistar rat

model. Overall, the observed results for the DLP-printed 3D composite scaffolds of MA-κ-CA and BSNP demonstrate their biocompatibility and suitability for bone tissue engineering.

Keywords: Digital light processing, Carbohydrates, Hydrogels, composite, 3D bioprinting, Bone tissue engineering



TOC: In this study, the favorable biochemical and biophysical cues offered by the DLP-printed 3D MA-κ-CA-BSNP composite hydrogel scaffolds establish them as promising biomaterials for developing bone substitutes to treat and regenerate bone defects.

8. **Paper title:** Injectable Adhesive Hydrogels for Soft tissue Reconstruction: A Materials Chemistry Perspective

Authors: Pritiranjan Mondal, Indranil Chakraborty, Kaushik Chatterjee

Publication date: 23/08/2022

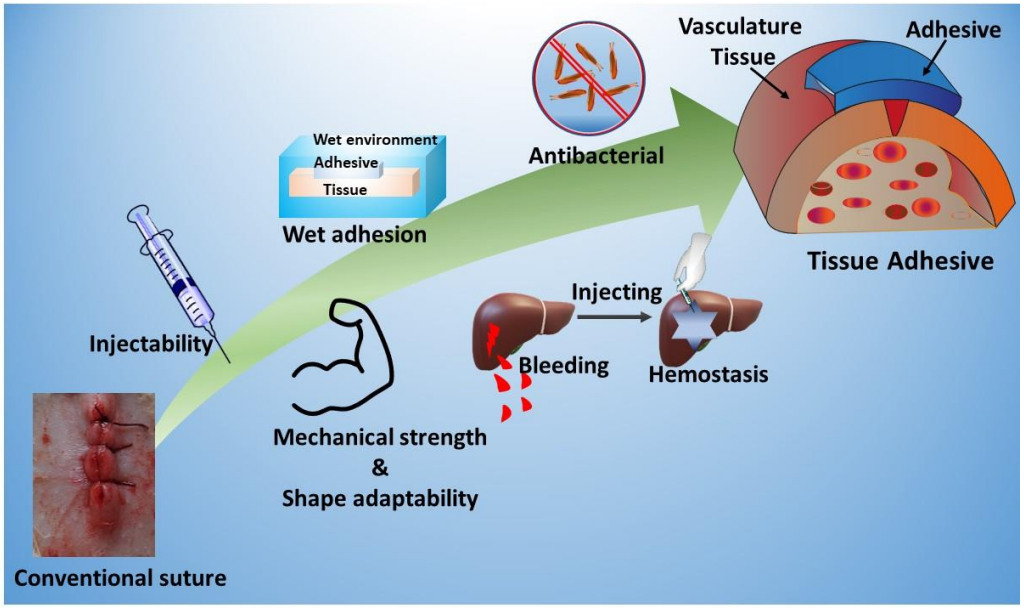
Journal: The Chemical Record

Link: https://doi.org/10.1002/tcr.202200155

Highlight the importance discoveries:

Injectable bioadhesives offer several advantages over conventional staples and sutures in surgery to seal and close incisions or wounds. Despite the growing research in recent years few injectable bioadhesives are available for clinical use. In this review article, we summarize and proposed the key chemical features that enable the development and improvements in the use of polymeric injectable hydrogels as bioadhesives or sealants, their

design requirements, the gelation mechanism, synthesis routes, and the role of adhesion mechanisms and strategies in different biomedical applications. It is envisaged that developing a deep understanding of the underlying materials chemistry principles will enable researchers to effectively translate bioadhesive technologies into clinically-relevant products.



TOC: This review research provide a strong foundation for understanding and realizing the current progress for materials scientists, clinicians, and a broader research community interested in polymeric injectable adhesive hydrogel for biomedical applications.

9. **Paper title:** Metamorphosis of Ruthenium-Doped Carbon Dots: In Search of the Origin of Photoluminescence and Beyond

Authors: Kallol Bera, Abhishek Sau, Pritiranjan Mondal, Rukmini Mukherjee, Debdatto Mookherjee, Amaresh Metya, Asish K Kundu, Debranjan Mandal, Biswarup Satpati, Oishee Chakrabarti, Samita Basu

Publication date: 04/10/2016

Journal: Chemistry of Materials

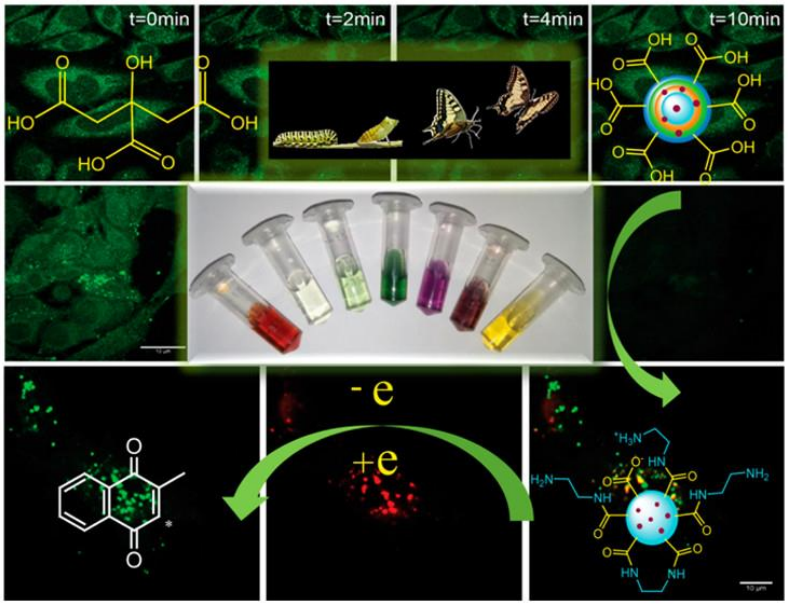
Link: https://doi.org/10.1021/acs.chemmater.6b03008

Highlight the importance discoveries:

Carbon dots (CDs) are known to have a wide range of applications, yet our understanding of their structures and chemistry remains uncertain because of their highly complex nanostructured framework. Here we attempt to elucidate the molecular structure and intrinsic mechanisms governing photoluminescence (PL) of CDs by trapping seven visibly distinct

colored intermediates that evolved during pyrolytic metamorphosis of citric acid with dopant Ru(III). The “excitation-dependent” PL of doped CDs, Ru:CDs, can be tuned by ethylenediamine (EDA), yielding “excitation-independent” highly fluorescent nanodots, Ru:CNDEDAs. To mimic the optical and chemical properties of CDs, we devise a unique model cocktail comprising multiple fluorogenic molecules that truly supports the existence of chemically switchable conjugated moieties in CDs. We propose a plausible molecular level framework of CDs on the basis of spectroscopic findings and existing literature regarding thermal decomposition of CA. The PL of chemically engineered Ru:CNDEDAs is quenched efficiently by photoinduced electron transfer (PET) phenomenon. By exploiting the PET process, we also develop an important sensing platform for quantifying toxic and carcinogenic quinone derivatives in live HeLa cells that can be used for drug screening. Moreover, the distribution pattern of these photoluminiscent nanodots in HeLa cells is studied to demonstrate their utilities as endosomal markers.

Keywords: Carbon dots (CDs), photoluminescence, photoinduced electron transfer, endosomal markers.



TOC: In this study, the seven stable intermediates of CDs have been trapped during the pyrolysis of citric acid (CA) with dopant Ru(III), which are identified even by the naked eye in cases in which Ru(III) acts as an indicator. It is shown that the quenching of the PL of Ru:CNDEDAs upon addition of a model quinonoid drug (MQ) demonstrates their utility as toxic quinone sensors in HeLa cells.

10. Paper title: Formation of a gold–carbon dot nanocomposite with superior catalytic ability for the reduction of aromatic nitro groups in water

Authors: Pritiranjan Mondal, Krishanu Ghosal, Swarup Krishna Bhattacharyya, Mithun Das, Abhijit Bera, Debabrata Ganguly, Pawan Kumar, Jaya Dwivedi, RK Gupta, Angel A Martí, Bipin Kumar Gupta, Subhabrata Maiti

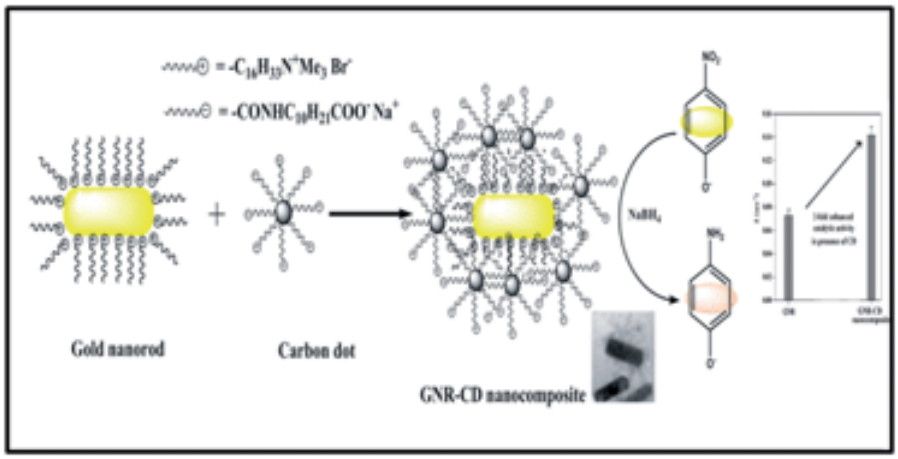
Publication date: 31/03/2014

Journal: RSC Advances

Link: https://doi.org/10.1039/C4RA02837F

Highlight the importance discoveries:

In this study, we report the synthesis of a gold–carbon dot nanocomposite and its utility as a recyclable catalyst for the reduction of aromatic nitro groups. The presence of carbon dots on gold nanosurfaces enhanced the reduction rate by two-fold.



TOC: A new class of gold–CD nanocomposites was developed, which show high efficiency in catalyzing the reduction of different aromatic nitro groups.