Hybrid Flexible Films with Tuned Properties for Multifunctional Applications

Shohei Nishimura,[123] Ashok Kumar Meiyazhagan,[1*] Zixing Wang,[1] Ashleigh Smith,[4] Peter Owuor[1], Angel A. Marti,[4] Robert Vajtai,[1*] Pulickel M Ajayan[1*]

[1]Department of Material Science & Nano Engineering, Rice University, Houston, Texas, U.S.A.[2]Nakatani RIES: Research & International Experiences for Students, Rice University, Houston, Texas, U.S.A.
[3]Department of Material science and Engineering, Tohoku University, Sendai, Japan. [4]Department of chemistry, Rice University, Houston, Texas, U.S.A
Corresponding authors: ajayan@rice.edu; rv4@rice.edu; ma37@rice.edu

Objective

Development of multifunctional hybrid films with tuned luminescence and electrical conductivity for wide applications

Introduction

Quantum Dot (QD) [1]

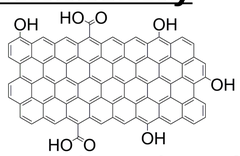
- Particles size (2-10 nm) semiconductor
- Luminescence, tunable light emission depending on the QD's size

Reduced Graphene Oxide (rGO)

- Electrical conductivity[2]

Luminescence and Electrical Conductivity

- Potential for application as electronic optical devices [3]



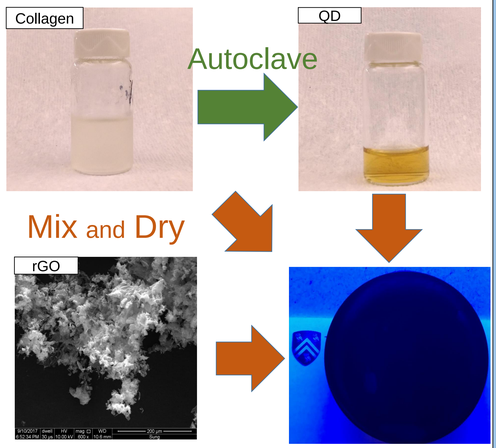
Collagen

- Cost effective, biocompatible polymers and consists of peptides[4]

Methods

QD

- Autoclave collagen under high pressure
- Amino acids are broken down into QDs [5]



Film

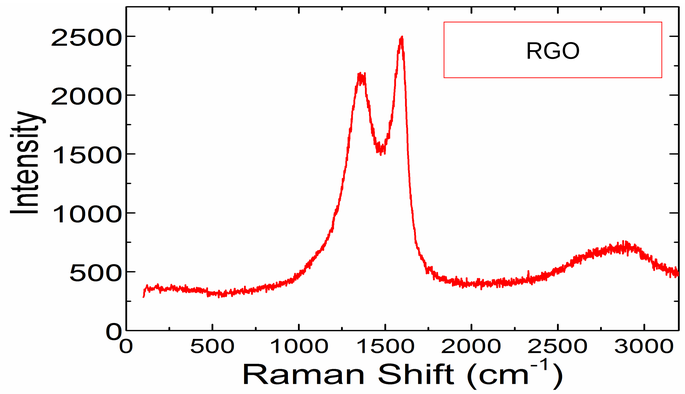
- Hybrid films are formed by blending collagen with different weight (wt%) of QD and rGO

Table: Wt% of QD and rGO in different films

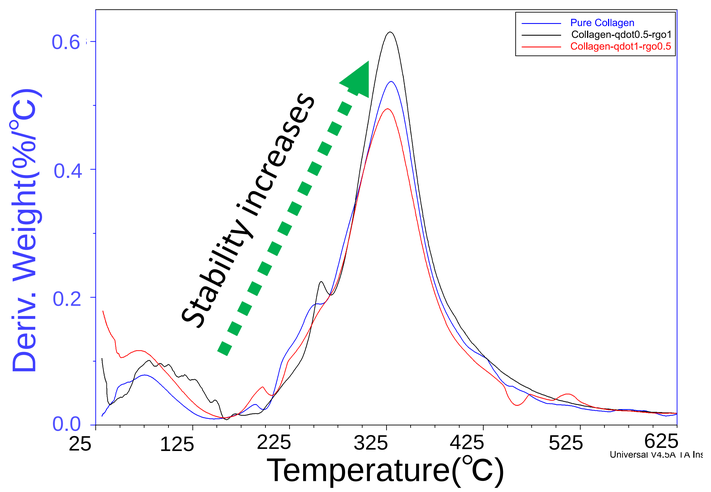
	Film 1	Film 2	Film 3	Film 4
QD (wt%)	0	0.5	1	2
rGO (wt%)	0	1	0.5	0

Result

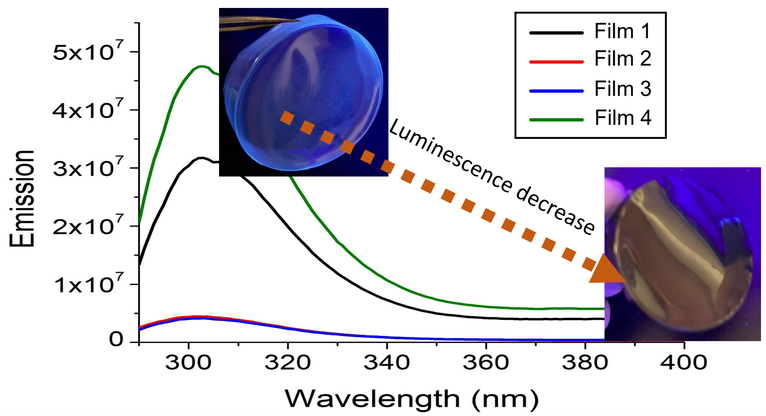
Raman Spectroscopy



Thermal Stability of Select films



Photoluminescence of Select films



Discussion

- We report a simple, economical and green technique for the preparation of hybrid, flexible films using collagen wastes
- The hybrid films were developed by varying the proportion of GO and rGO
- The presence of D and G Raman peaks confirm successful conversion of GO into rGO
- Thermal stability of the hybrid films shows gradual increase with increase in rGO
- Hybrid films with higher proportion of QD shows higher luminescence property
- The thus formed hybrid materials is expected to possess other interesting properties such electrical conductivity, mechanical stability and biocompatibility

Conclusion

- Hybrid films were developed by blending QD and rGO with the collagen matrix
- The formed hybrid materials were found to have interesting properties such as thermal stability, luminescence, and other promising features such as mechanical stiffness, biocompatibility, etc. which were under investigation.
- This approach hints way for the formation of advanced materials with low cost wastes.

Future work

- The presence of different functional groups will be examined using techniques such as X-ray Photoelectron Spectroscopy (XPS), Fourier transform Infra-red spectroscopy (FTIR).
- The mechanical properties of the hybrid films at varying temperatures will be explored using Dynamic Mechanical Analysis (DMA)
- Electrical conductivity and life time measurements were in progress.
- Biocompatibility of the formed materials will be studied

References

[1] Zhou, M., and Ghosh, I.(2007). Current trends in peptide science quantum dots and peptides: A bright future together. *Biopolymers, Peptide Science Section*, 88(3) ,pp.325-339.
[2] Park, W. (2017). Electrical and thermal conductivities of reduced graphene oxide/polystyrene composites, *Applied Physics Letters*. 104
[3] Gallego, A. (2012). Electrical conductivity and luminescence in coordination polymers based on copper(I)-halides and sulfur-pyrimidine ligands. *Inorganic Chemistry*. 51(1). Pp.718-727
[4] Di, Lullo, GA. (2002). Mapping the ligand-binding sites and disease-associated mutations on the most abundant protein in the human, type I collagen. *The Journal of Biological Chemistry.* 277(6). Pp.4223-42231.
[5] Hauser, EAC., Zhang, S. (2010). Peptides as biological semiconductors. *Nature*. 468. pp. 516-517.

Acknowledgements

This research project was conducted as part of the 2017 Nakatani RIES Fellowship for Japanese students with funding from the Nakatani RIES. For more information please see http://nakatani-ries.rice.edu/