CONFIDENTIAL

August 20th 2013
KRI, Inc, Organic Device Materials Laboratory

— Technical Resume —

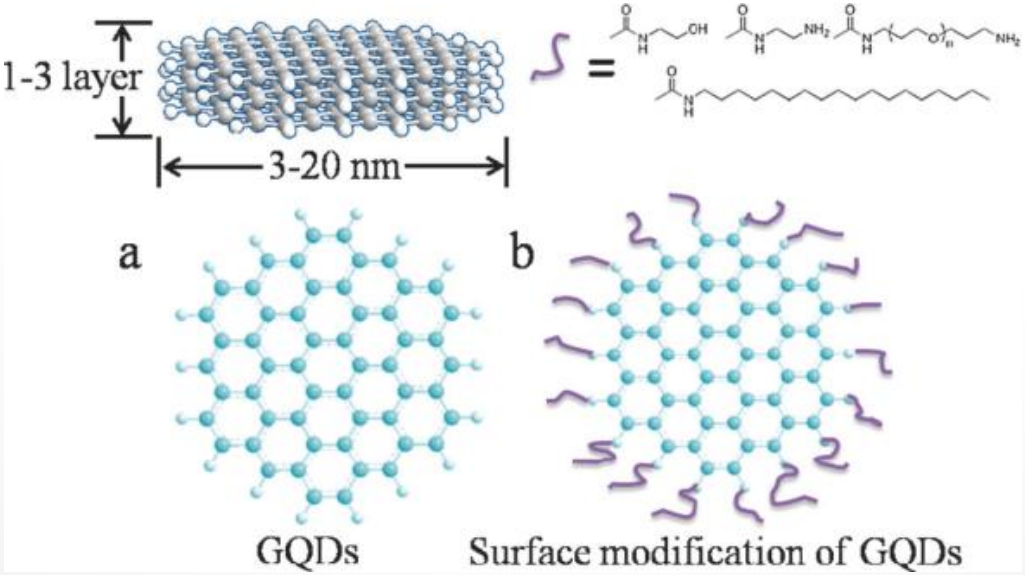
Graphene Quantum Dots (GQDs) as Fluorescent Materials

【KRI】

KRI, Kyoto-based institute, can give you paid-study on a subject described in this resume. Rights of patents created through the paid-study are attributed to the client when more than ¥20,000,000 is paid to KRI as expenditure by the client.

【Background】

GQDs
2-20nm 1-3-layered graphenes have collected enormous attention as cheap and safe substitutes of semiconductor quantum dots made of Cd, Ir, Ga, S, Se and P. Not only excellent quantum yield but also sharp emission wavelength could be expected, although GQDs are presently not perfect. Moreover, GQDs can be allowed further modification to give them hydrophobicity to make it composite with other materials such as plastics. KRI has been studied GQDs and accumulated original synthetic techniques to enhance properties of GQDs. This brochure shows what KRI can do to help you utilize GQDs



Synthesis

There are two general approaches to create GQDs. One is topdown method and another is a bottomup method. The former: Graphene oxide is produced then cut to desired size to make GQDs. The latter: Low molecular weight compounds are polymerized to nm-size to obtain GQDs. Cheap and safe materials can be selected as starting materials of both methods.

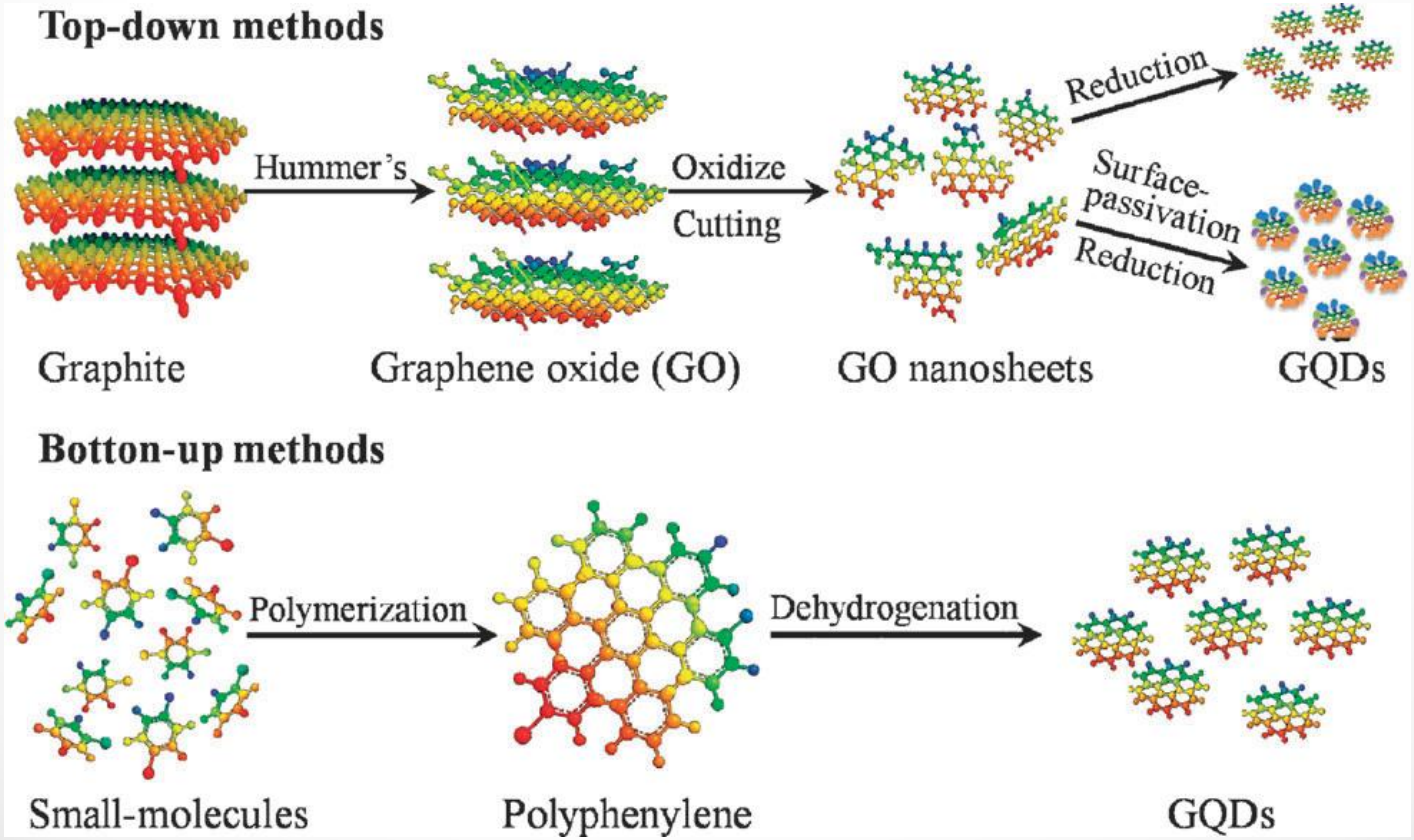


Table 1. Comparison of GQDs and Semiconductor quantum dots (SQDs)

Types	Optical Properties			Stability	Toxicity	Cost
	Quantum yiekd	Emmission	Half-height			
GQDs	max 90+%	380-570nm (No red)	>40nm (ca. 70nm)	◎	◎	◎
SQDs	CdSe 10-25 % ZnSe/CdSe 30-50 %	480-640nm	40nm>	×	×	×

Fig 1. Fluorescence spectra of the GQDs obtained in the KRI

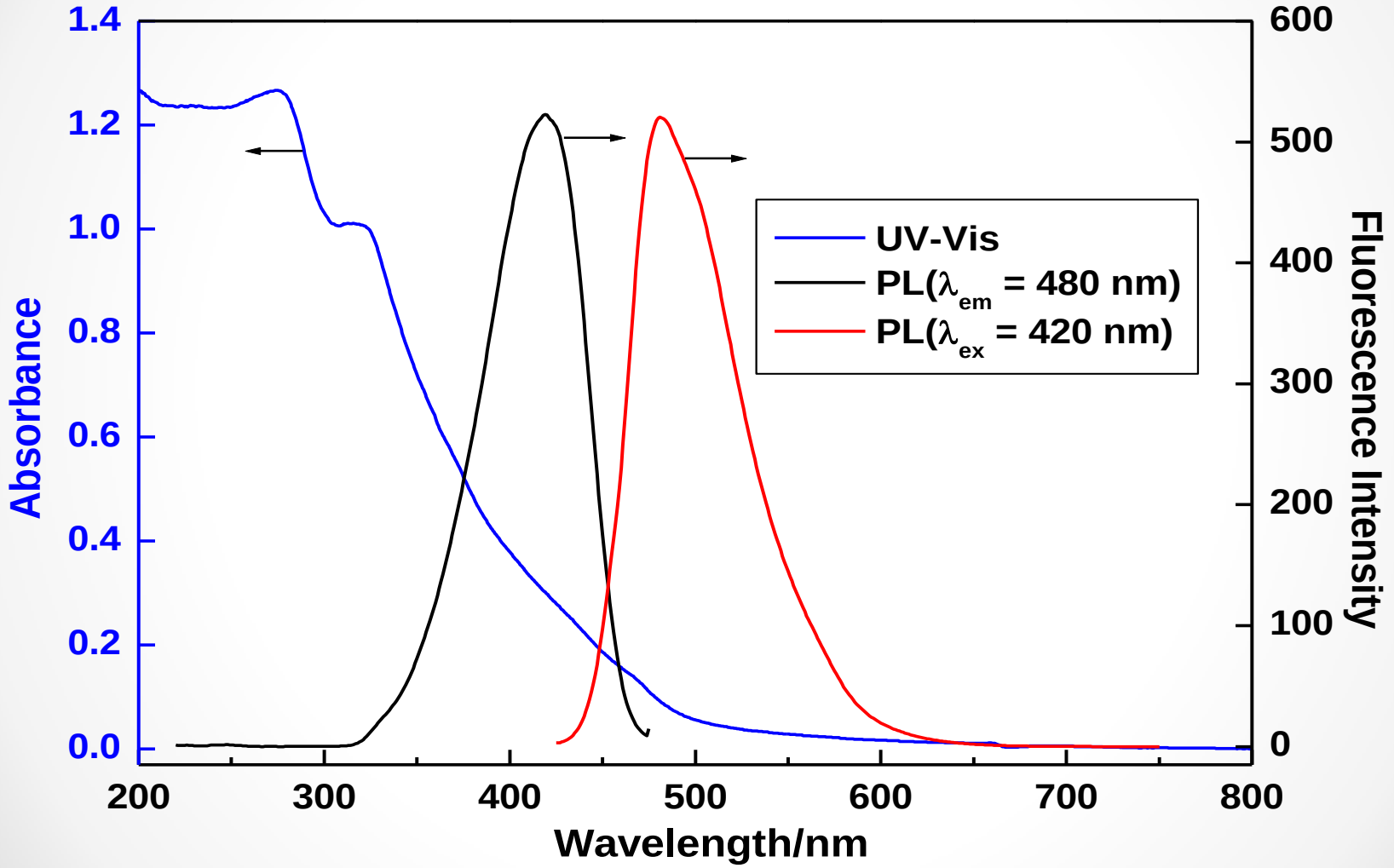
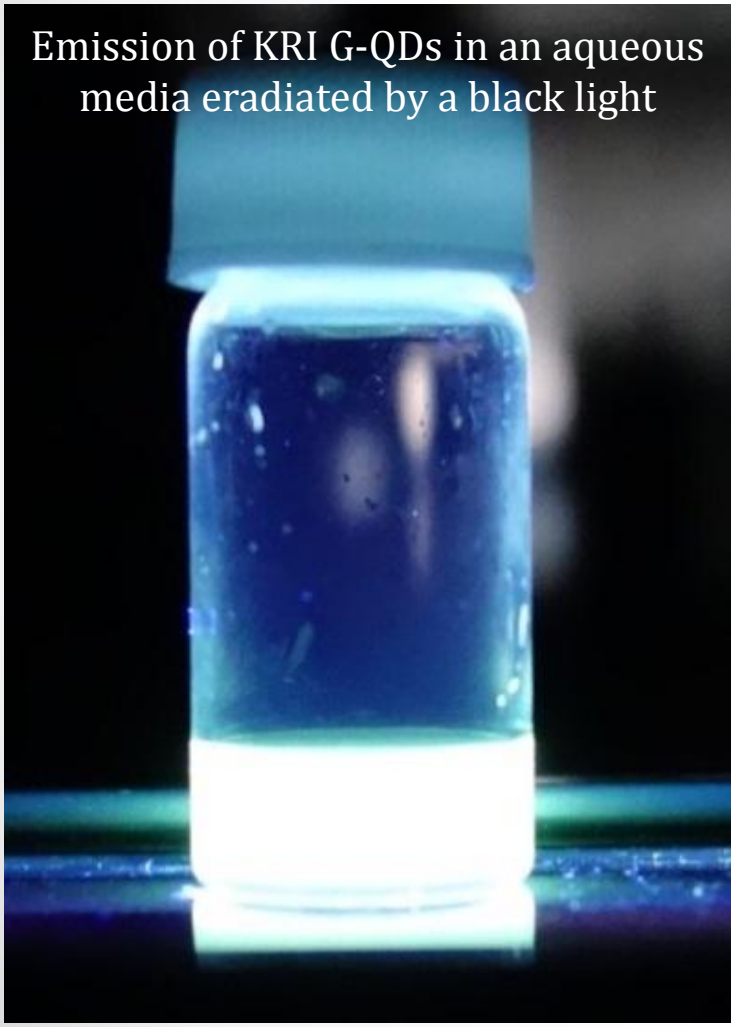
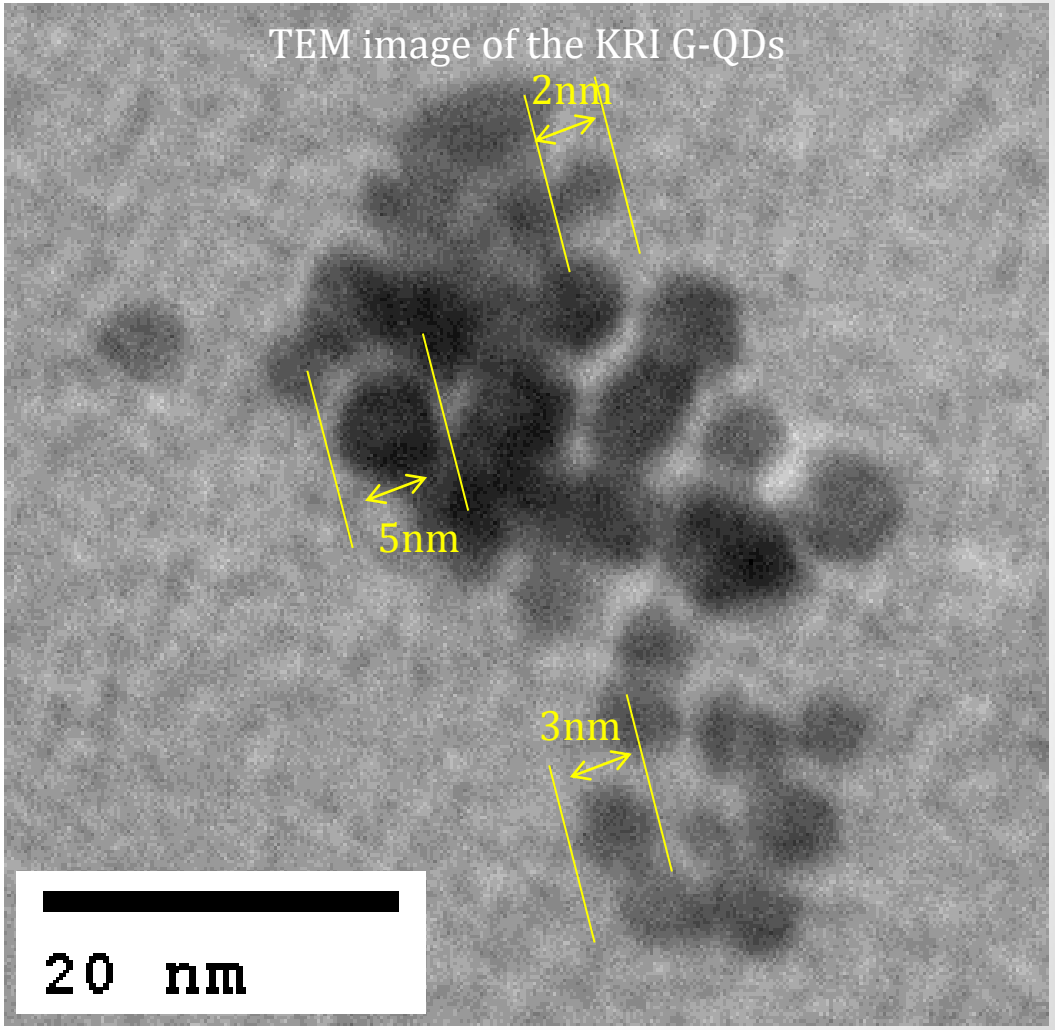


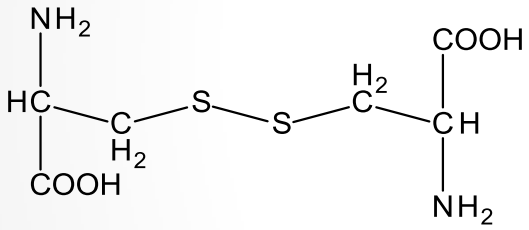
Fig 2. Fluorescence spectra of the GQDs obtained in the KRI



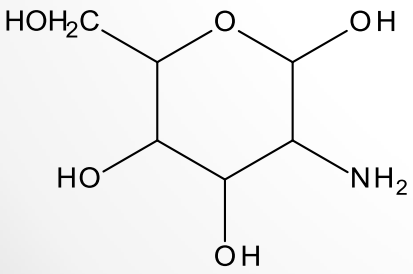


【Proposal I : Synthesis of high quantum yield G-QD】

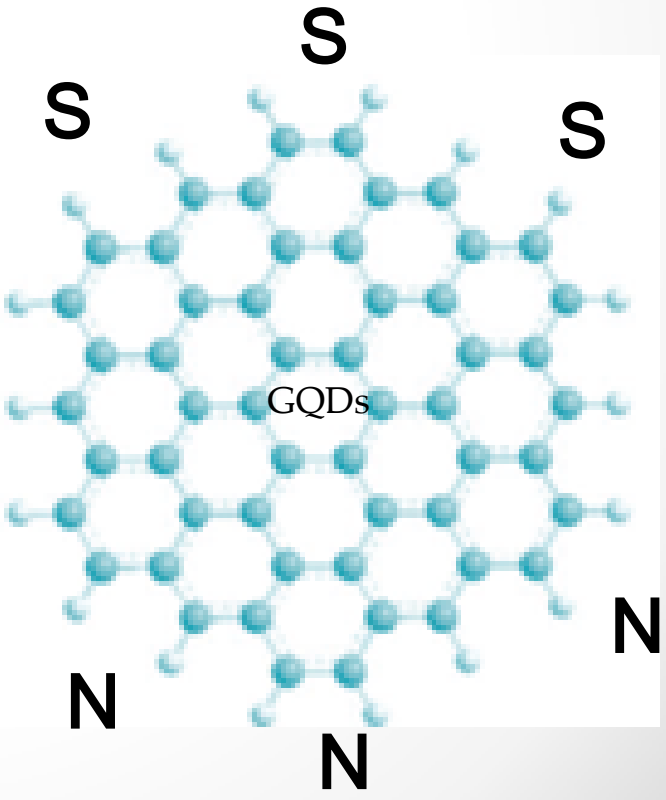
Although quantum yield of general GQDs is not so high that surpasses that of semiconductor quantum dots, introducing such hetero atoms as S, N, and P in the GQDs could enhance their quantum yields. To introduce hetero atoms mentioned are trying to accomplish using the hetero atom-containing starting materials like cystein.



Amino acid
Cystine

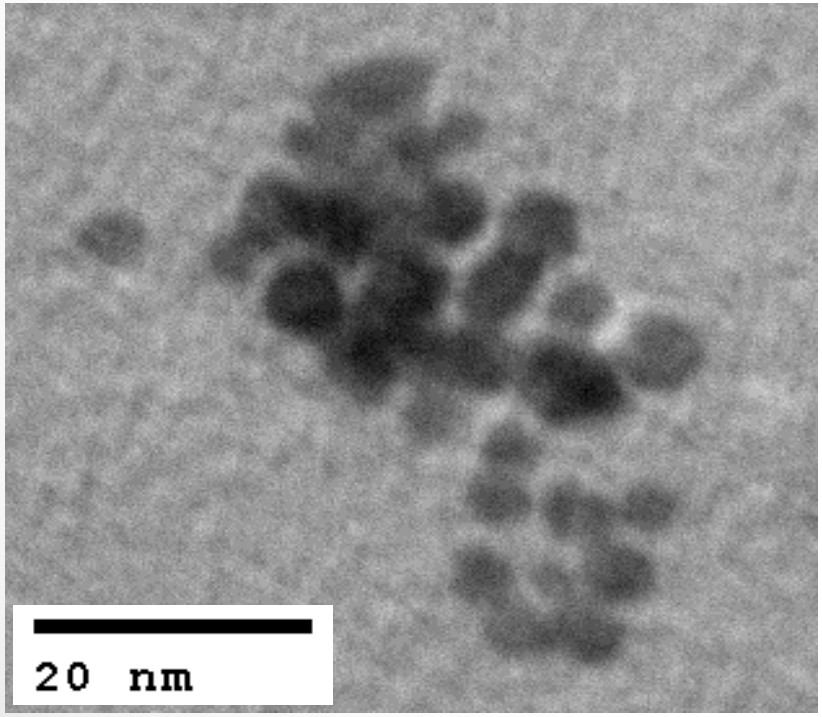


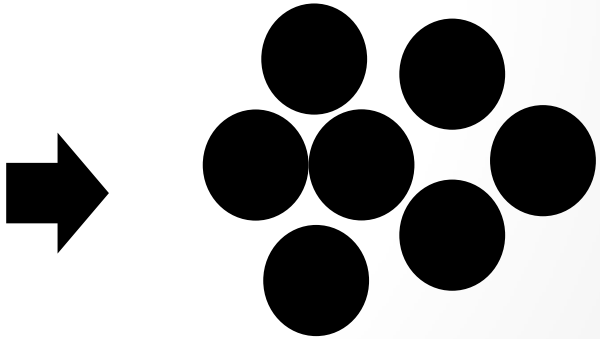
Sugar
Glucosamine



【Proposal II : Synthesis of GQDs eradiate sharp emission and longer wavelength emission】

Although emission of general GQDs is not so sharp and long-waved one that compared with those of semiconductor quantum dots, uniform and larger size of GQDs could sharpen the emission and enlarge the emission wavelength. To uniform and enlarge the size of the GQDs are trying to use meso or macro porous materials as a size-exclusive reactor.





Uniform and large diameter

【Refferences】

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