

Development of Griffin Quantum Dot based Portable Micro Device for Detecting High Speed and High Efficiency Multiplex Heavy Metals

1. Summary

■ Purpose of and Need for Research

- This research applies various environmental sensors and elements using single layered griffin quantum dots combined at high transference number and excellent electrical, physical, chemical and facial features of griffin material which became a popular next generation new material recently and integrates micro fluidic device for sample preconditioning, thereby purporting to develop griffin quantum dot based integrated environmental elements for measuring ultra-sensibly heavy metals of water quality which can substantiate from a single device to identify the targeted environmental heavy metals from injecting samples.
- Such application of griffin quantum dots as environmental sensors/elements is an area which has not been yet researched and was successfully conducted in this research.
- We can not only procure the original technology relating to the surface griffin quantum dots, but through commercialization, the technology is determined to have a big ripple effects also of decreasing outside dependency on environmental sensors.

■ Contents and Scope of the Research

- Final goal of the research and development is to develop a griffin quantum based portable micro integrated device for detecting high speed and high efficiency multiplex heavy metals which can diagnose at the site and subject materials of detection are silver, lead and mercury, with detection measurement range using the griffin quantum dots of 1~100ppb.
- Considering the heavy metal detection standards of environmental standards of water quality by the Ministry of Environment, mercury is not detected based on standards of river, lake and underground water, lead is 100ppb or below and based on drinking water, mercury is 1ppb and lead was 50ppb or below. Therefore, depending on the heavy metals subject to detection for the detection measurement ranges using the griffin quantum dots, we will select the limits to be 15ppb for mercury, 50 ppb for silver and 100ppb for lead.
- Heavy meatal concentration conditions is aimed at concentration of 80% or more and includes optimized ion exchange resin development and establishing pump and valve conditions for developing sample preconditioning system for high concentration.

2. Research Results

■ Results of Research and Development

- Single layer griffin quantum dot synthesis
 - In this research by using graphite Nano particles in the size of 4~5 nanometers, we manufactured griffin oxidization quantum dots using simple, fast and highly pure griffin quantum dots and hummer method to identify optical mechanisms of griffin quantum dots that are not accurately identified in the past and applied heavy metal detection using unique griffin quantum dot optical features.
- Through improving griffin oxidation quantum dot surface and body molecule fixation, produced lead detection sensor which is a heavy meatal detection subject.
 - Rather than the griffin oxidization quantum dots made by the existing converted hummers method with low quantum dot efficiency, by using only sulfuric acid and nitric acid, we were able to produce griffin oxidization quantum dots which have significantly higher quantum dot transference number.
 - The bio sensing and sensor system using the griffin oxidization quantum dots made in this research can identify optically existence of detection materials using unique fluorescent feature of griffin oxidization quantum dots without using a dye to dye the targeted materials
- Detection screening of detection subject heavy metals, mercury and silver, from off-chip through oxidization griffin micro arrays of Nano size
 - This research produces micro arrays using oxidized griffin in the size of Nano from detection subject heavy metals other than lead, which are mercury and silver, and conducts heavy metal detection using the laser scanner.
 - Especially, in this research by using aptamers which captures each heavy metal ion uniquely, there is advantage of possible detection of multiplex heavy metal using the micro array system.
- Through exchange resin of positive ion of silver and lead, which are detection subject heavy metals, off-chip sample concentration test
 - This research is a sample concentrating preconditioning test for detecting of detection subject heavy metals highly efficiently, after capturing the heavy metal ions to be detected using the positive ion exchange resin, it concentrates the desired sample highly using released solutions.
 - Especially, as this experiment is an experiment which is a step before concentrating the sample in on-chip subsequently, it has advantage of ability to highly concentrate the sample through high capture transference number of positive ion exchange resin and concentration efficiency.
- Determination of ultra-sensible small fluorescent detection system design specifications (Nano Scope Systems)
 - The domestic product of the portable fluorescent scanner which is the development goal of this research, has not been yet developed for commercial purpose and in the fields requiring

this device, foreign products with similar specifications are used.

- Development of the portable fluorescent scanner procures versatility as a product by procuring diversity of wavelength of excitation/emission and to specialize the assignment to the purpose, the purpose is to establish technology for downsizing.
- Through the research in the first year, we decided specifications of the fluorescent scanner, designed a optical system for establishing compact system, selected suitable detailed element components and developed a software platform testing.
- Development of copper heavy metal ion detection sensor using two-photon fluorescent griffin oxidized quantum dots
 - In this research, using a pulse laser system of phamto second unit, we analyzed two-photon fluorescent in depth and accurately compared with fluorescent occurring from one photon
 - Especially, by using two-photon fluorescent, we applied copper heavy metal ion detection sensor having high sensitivity and selection and we found that the mechanism was not energy metastasis, but was by electronic metastasis.
- Microfluidic based sample preconditioning system development
 - Using the microfluidic system, through preconditioning technology of heavy metal ion sample, we realized one unit process of selective refinery, concentration and separation of analyzed materials on top of one downsized chip.
 - By using positive ion exchange resin on the chip, we captured and concentrated the heavy metal ion selectively and by separating the materials which interfere with the analysis such as negative ion and other organisms, we intend to increase the sense of the griffin quantum dot based environmental sensor finally.
- Development of griffin quantum dot micro array based microfluidic sensor for detecting heavy metals
 - Using aptamers which capture each heavy metal ion uniquely, there is an advantage of possible detection of multiplex heavy metals using micro array system and by applying microfluidic system, integration with sample preconditioning system is possible.
- Micro array chip fluorescent measurement system development
 - By constructing ultra-sensible fluorescent detection system test modules, after conducting actual sample tests, sample products were designed and for realizing the basic design concept, by producing elements and testing each element, the platform for testing was produced.
- Integration of sample preconditioning system and griffin quantum dot micro array
 - In a single device integrating the ultra-sensible griffin quantum dot micro array and microfluidic sample preconditioning system, single detection of target heavy metals, selection and multiplex detection were conducted.
- Development of portable fluorescent scanner

- For developing a portable fluorescent scanner, by selecting placement of optical system and stage scanning method in the form of confocal system, we designed for possible reduction of space and material costs.
- Development of micro array chip fluorescent system (Nano Scope Systems)
 - The fluorescent scanner produced in this research can be used by connecting directly to notebook PCs without any additional hardware due to portability of the entire system.
 - From video of fluorescent scanner, necessary video information and signal can be obtained and it was suitable for site measurement use from perspective of portability. Moreover, the video observation area is designed to enable continuously filming by linking to the automatic stage.
- Collection, detection and analysis of actual water quality contaminants
 - Compared to the existing device, the concentration of heavy metals included in the actual water quality sample could be analyzed effectively through high sensitivity.

■ **Plans to Utilize the Results of Research and Development**

- Production of downsized device based on lap on a chip and application as a biosensor using excellent optical features of griffin which has become popular as the next generation new material are possible for new sensor development and securing the original technology of the nation.
- Especially, mass capacity sample processing is possible and it is a highly portable MEMS based micro device and can be produced easily. The heavy metal detection sensor of integrated type using griffin quantum dot micro array capable of ultra-sensible optical analysis is expected to be utilized a lot as a water quality diagnosing site analysis device.
- Microfluidic system based real time water quality monitoring technology is an area with growth potentials and big ripple effects which will lead the future BT-NT-IT convergent market and also, it is expected to have a large ripple effect on other industries like energy, wastes and health, etc.

Source: National Digital Science Library