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# Petrochemicals-derived fluorescent nanoparticles for tracer applications

**Statement of the Problem:** Fluorescent nanoparticles are becoming high demand products in the oil industry for application as tracers for reservoir monitoring to understand the flow pattern between the wells during waterflood operations and optimize the oil production. The common tracers, based on organic dyes, are not stable in harsh downhole conditions and are difficult to incorporate. Fluorescent carbon-based nanoparticles – carbon quantum dots (CQD) have recently drawn much attention due to outstanding fluorescence properties and pending applications towards chemical sensing and bio imaging. In most cases, CQDs outperform the traditional semiconductor-based quantum dots. They are also inherently non-toxic and stable in high temperature and pH conditions and are resistant to photobleaching. Purpose: The purpose of this study is development of low cost and scalable methods for synthesis of fluorescent carbon-based nanoparticles from petrochemical precursors.

**Methodology & Theoretical Orientation:** CQDs were synthesized using electrochemical redox reactions. Platinum mesh was used for anode and cathode electrodes, and 0.1M NaOH as an electrolyte in a two-compartment cell. For preparation of fluorescent core-shell nanoparticles colloidal synthesis was applied.

**Findings:** Electrochemical carbonization of low molecular weight petrochemical precursors containing carbon, oxygen, and hydrogen resulted in both water-soluble and oil-soluble CQDs of 10-20 nm size. Addition of nitrogen, boron, silicon or sulfur sources to the reaction produced doped CQDs with the fluorescence bands either blue-(N, B or Si) or red-shifted (S) with respect to undoped particles. Synthesized particles were stable for 30 days in API brine at 80°C and have been recovered at 76% in a flow experiments run through Berea sandstone core.

**Conclusion & Significance:** A facile method has been developed for synthesis of large quantities of fluorescent carbon nanoparticles which can be recovered even from low permeable cores. This can open new opportunities for *in situ* monitoring of reservoir communication and oil production.

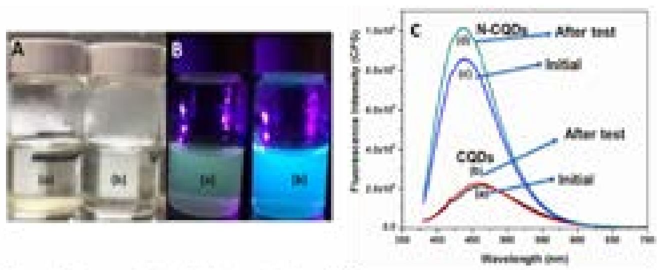


**Figure 1.** Thermal and API brine stability of fluorescent nanoparticles[1]. Plate (A): Image of stable suspension of pure CQDs (a) and nitrogen-doped CQDs (b) in API brine at 80 °C after 30 days. Plate (B): Image of stable suspensions of CQDs (a) and nitrogen-doped CQDs (b) under UV-light after 30 days in API brine at 80 °C. Plate (C): Floresence spectra of pure CQDs before (a) and after (b) exposure to API brine-stabilized solution, and nitrogen-doped CQDs before (c) and after (d) the similar test.

## Recent Publications


1. Zuniga C et al. (2016) Long term high-temperature stability of functionalized graphene oxide nanoplatelets in Arab-D and API brine. ACS Appl. Mater. Interfaces. 8(3):1780-1785.
2. Li H et al. (2012) Carbon nanodots: synthesis, properties and applications. J. Mater. Chem. 22(46):24230-24253.
3. Deng J et al. (2015) Large scale preparation of graphene quantum dots from graphite oxide in pure water via one-step electrochemical tailoring. RSC Adv. 5(38):29704-29707.


## Biography

Valery Khabashesku obtained his professorial Doctor of Science Degree and Doctoral CSc Degree from Zelinsky Institute of Organic Chemistry of the Russian Academy of Sciences in, and MSc Degree in Chemistry from Lomonosov Moscow State University, Moscow, Russia respectively. At present, he is a Senior Technical Advisor for Nanotechnology at Baker Hughes a GE Company, one of the world-leading oil field services companies He is also an Adjunct Professor in the Department of Materials Science and Nanoengineering at Rice University; has been a Faculty Member in the Chemistry Department at the same university; Faculty Member- Department of Chemical & Biomolecular Engineering at the University of Houston, USA respectively. He has authored more than 300 publications and has been serving as an editorial board member for the journals of nanotechnology and materials.

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