

NMR Characterization of Surface Modified Si Quantum Dots

Typ práce / Project type	bakalářská práce / bachelor thesis OR SFG / student project
Jazyk práce / Language	česky / anglicky OR English
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Klíčová slova / Keywords	Quantum Dot, NMR Spectroscopy, Silicon
Časová náročnost / Workload	1-2 semesters OR 80 hours

Colloidal quantum dots (QDs) are nanocrystalline materials whose electronic, optical and transport properties as well as surface reactivity can be well tuned. Their properties are very different from the corresponding crystals of “ordinary” sizes. Discovery of QD materials, which was awarded by the 2023 Nobel Prize in Chemistry, dates back to the early 1980s and was focused on various binary compounds based on combinations of the elements of the groups II and VI, or III and V of the periodic table. Indeed, the iconic QLED TVs utilize either CdSe or InP QDs. Clearly, QDs based on less toxic and more readily available materials would be highly welcome. Group-IV materials could play an important role here. This project is concerned with Si QDs. Their surface has to be, nevertheless, chemically modified, to prevent oxidation and particles aggregation, consequently. We will address Si QDs substituted with alkyl groups.

NMR spectroscopy is a strong tool to assess a local chemical structure in the structures lacking a long range translational periodicity, which could be otherwise readily probed by diffraction methods.

Cíl projektu / Project Aims

1. To learn and test NMR methods applicable to the colloidal suspension of Si QDs.
2. To prove that alkyl groups are covalently bonded to Si QDs for selected sample batch/batches produced at specific synthetic conditions. Participation to material synthesis is optional.
3. Determination/estimate of QD size by means of NMR diffusion measurements

Co se naučíte / What you will learn

- * **Experimental Physics:** Liquid state NMR methodology for Si QD characterization, NMR diffusion measurements.
- * **Theory:** basis of NMR polarization transfer, origin of quantum properties of QDs.

Postup řešení projektu / Key milestones

- * Introduction, literature review
- * Selection and optimization of NMR spectroscopic methodologies.
- * Measurement of the target sample/samples.
- * Processing the measured data.
- * Writing report/bachelor thesis.

References

- [1] F. P. G. de Arquer, D. Talapin, V. V. Klimov, I. Y. Arakawa, M. Bayer et al., Science, 2021, 373, eaaz8541,
- [2] Kůsová K., Cibulka, O., Dohnalova, K., Pelant, I., Valenta, J. et al., ACS Nano (2010), 4, 8, 4495-4504
- [3] P. Galář, J. Kopenec, R. Král, F. Matějka, P. Zemenová et al., ACS Nano, 2025, 19, 2196,
- [4] Dračínský M.: NMR spektroskopie pro chemiky, UK PŘF Praha 2021 or a similar textbook in English.