In-vitro Evaluation and Cell imaging with Biocompatible Silicon Quantum Dots

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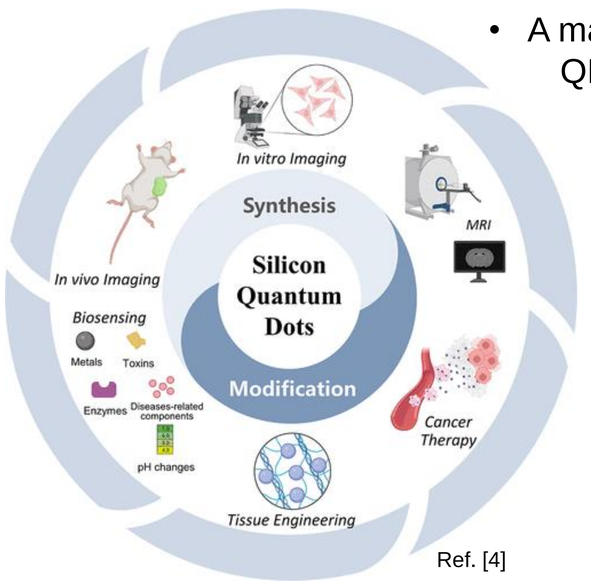
01 ABSTRACT

Silicon quantum dots (SiQDs) are promising materials for biomedical applications. This promise arises in part because of their tunable surface chemistry, as well as size dependent optical properties that provide luminescence arising from long-lived excited states that spans the visible and near infrared spectral regions. In stark contrast to conventional quantum dots that are based upon toxic metals, SiQDs are expected to provide a safe and stable alternative for biomedical applications such as live imaging, drug delivery, and clinical translation. In this study, we employ SiQDs bearing mixed surfaces of 10-undecanoic acid (*acid-SiQDs*) and poly(ethylene oxide) (*acid-oxSiQDs*) that were introduced via thermally-induced hydrosilylation. These surface groups render the SiQDs compatible with aqueous media and promote cell uptake. The resulting SiQDs were evaluated in vitro using a MTT assay and for bioimaging of fibroblasts (*MRC-5*) and cancer cells (*Hela cells*). The modified SiQDs showed high photoluminescence quantum yield up to 29.19% and 22.77%, respectively. The SiQDs showed extremely low toxicity even under a concentration up to 500 µg/ml at 24 h incubation. The as-prepared SiQDs demonstrated notable structural and luminescent properties, therefore representing promising biocompatible luminescent nanomaterials for cell imaging.

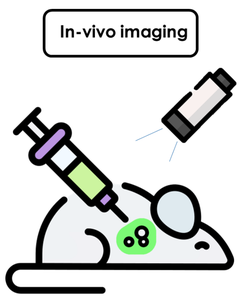
02 INTRODUCTION

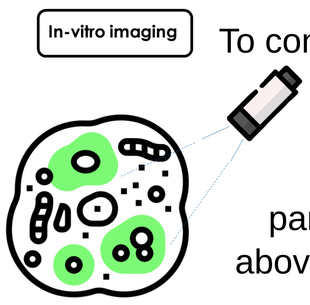
- Silicon quantum dots (SiQDs) have properties of great interest in photonics, electronics, and biomedical imaging applications.



Ref. [4]

- A major concern that limits QD use in biology and medicine is the toxicity associated with traditional heavy metal-based QDs.
- Challenges associated with the synthesis of SiQDs and lack of widespread availability have limited their use in areas such as bioimaging and biosensing [1].
- Health Canada and Food and the Drug Administration (FDA), require *in vitro* and *in vivo evaluation* prior to any clinical usage of nanomaterials [2, 3].



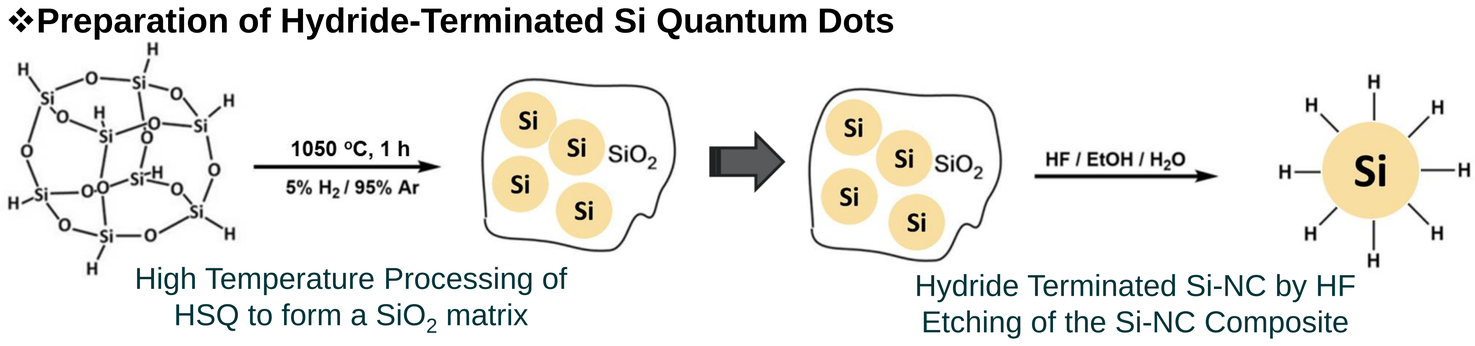


To confirm and validate the non-toxicity of the materials against all the parameters listed above.

- AQM has developed and commercialized SiQDs that show great promise for a range of *in vitro* and *in vivo* applications.

03 MATERIALS AND METHODS

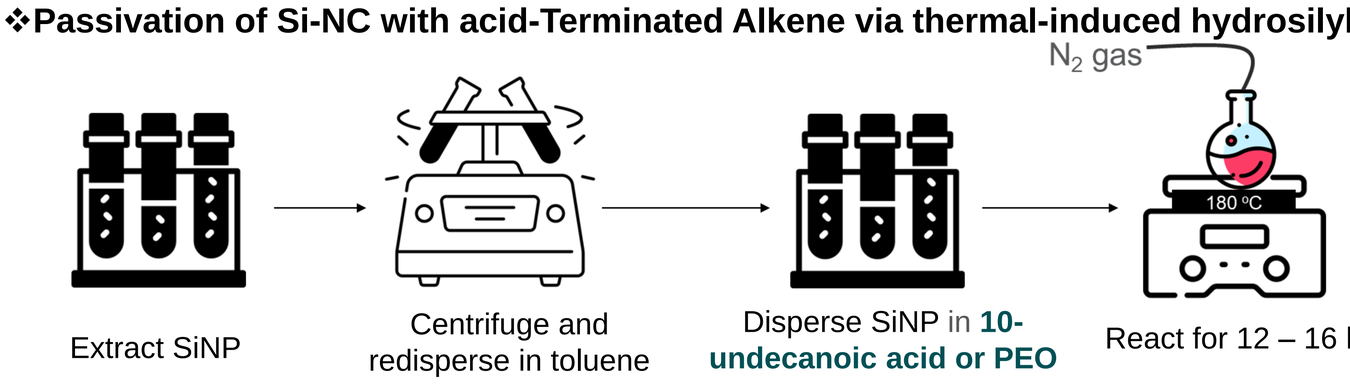
❖Preparation of Hydride-Terminated Si Quantum Dots



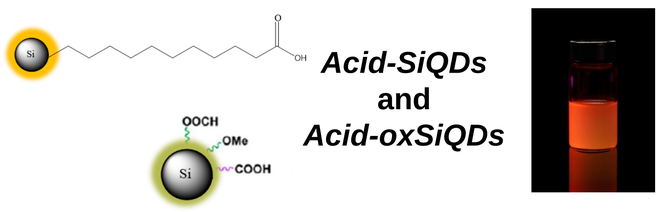
High Temperature Processing of HSQ to form a SiO_2 matrix

Hydride Terminated Si-NC by HF Etching of the Si-NC Composite

❖Passivation of Si-NC with acid-Terminated Alkene via thermal-induced hydrosilylation.



Extract SiNP → Centrifuge and redisperse in toluene → Disperse SiNP in **10-undecanoic acid or PEO** → React for 12 – 16 h → Purify



Acid-SiQDs* and *Acid-oxSiQDs

04 RESULTS

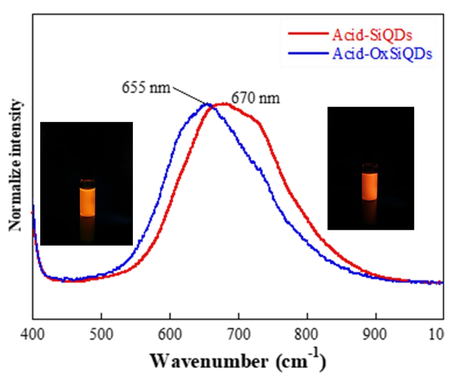


Fig. 1 Photoluminescence (PL)

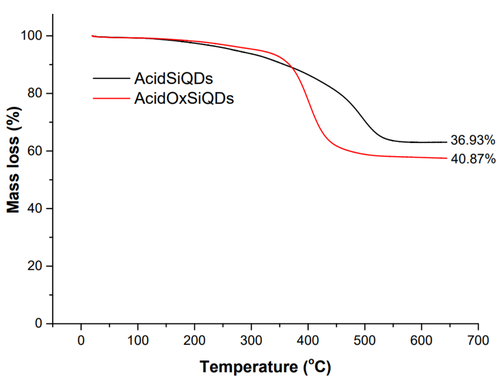


Fig. 2 Thermogravimetric analysis (TGA)

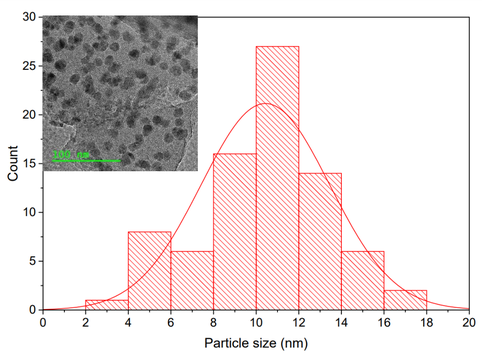


Fig. 3 Transmission electron microscopy (TEM)

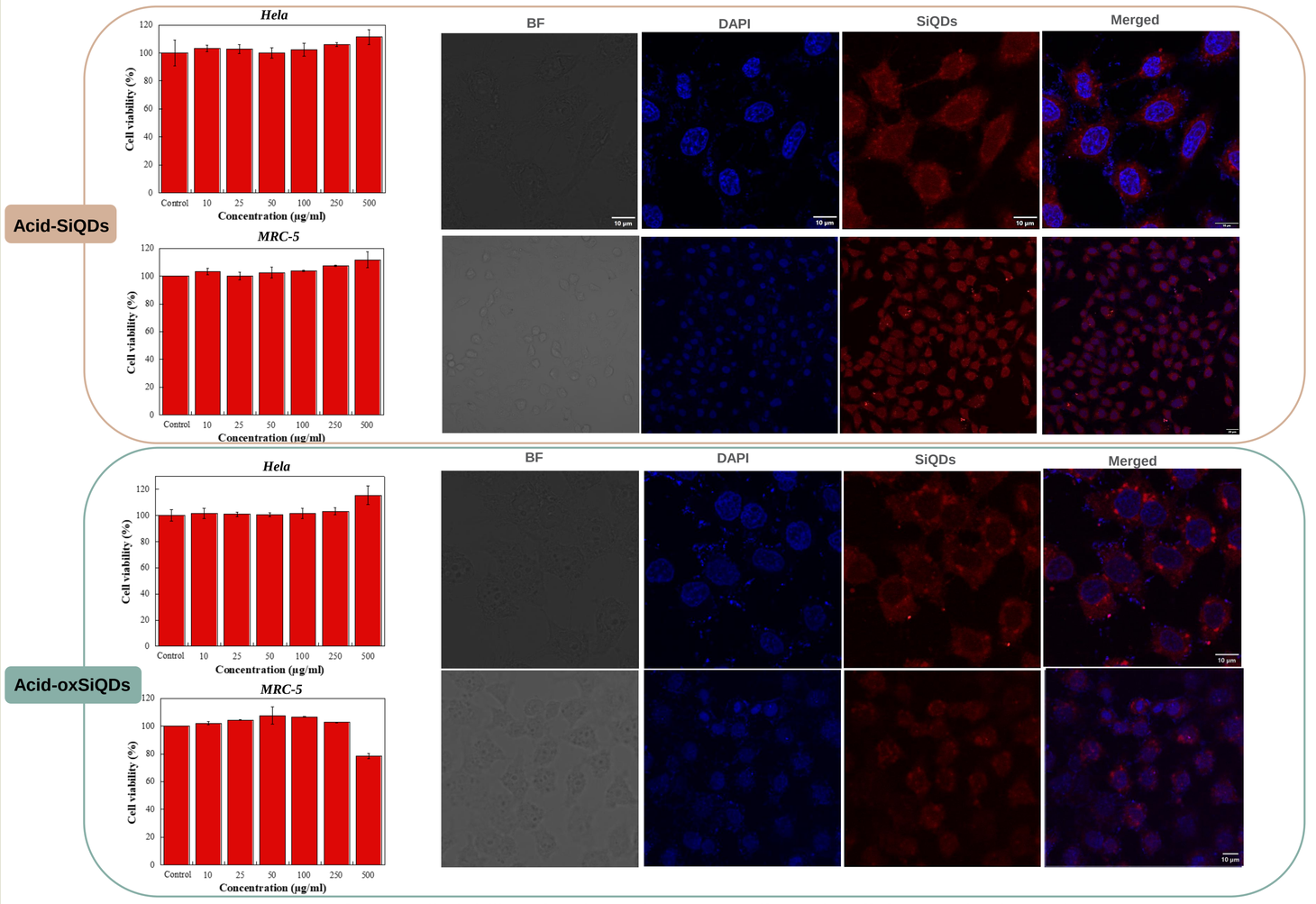


Fig. 4 Cell viability of Hela and MRC-5 cells and Cellular uptake for 24 h

05 CONCLUSIONS

- In summary, this work demonstrates a one-pot method of synthesizing SiQDs compatible with aqueous media via thermal hydrosilylation.
- Acid-SiQDs and acid-oxSiQDs depicted strong fluorescence emission with high quantum yield of 29.19% and 22.77%, respectively.
- Human fetal lung fibroblast cells and cervical cancer cells were incubated in acid-SiQDs and acid-oxSiQDs dispersion (0-500 µg/ml). In both cases, cell viability was >90%.
- SiQDs can penetrate cancer cells with photoluminescence. SiQDs have outstanding photostability and show low toxicity.

06 REFERENCE

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