Quantum Dot-Based Optical Sensor for MMP7 Biomarker with Molecularly Imprinted Polymers

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Introduction

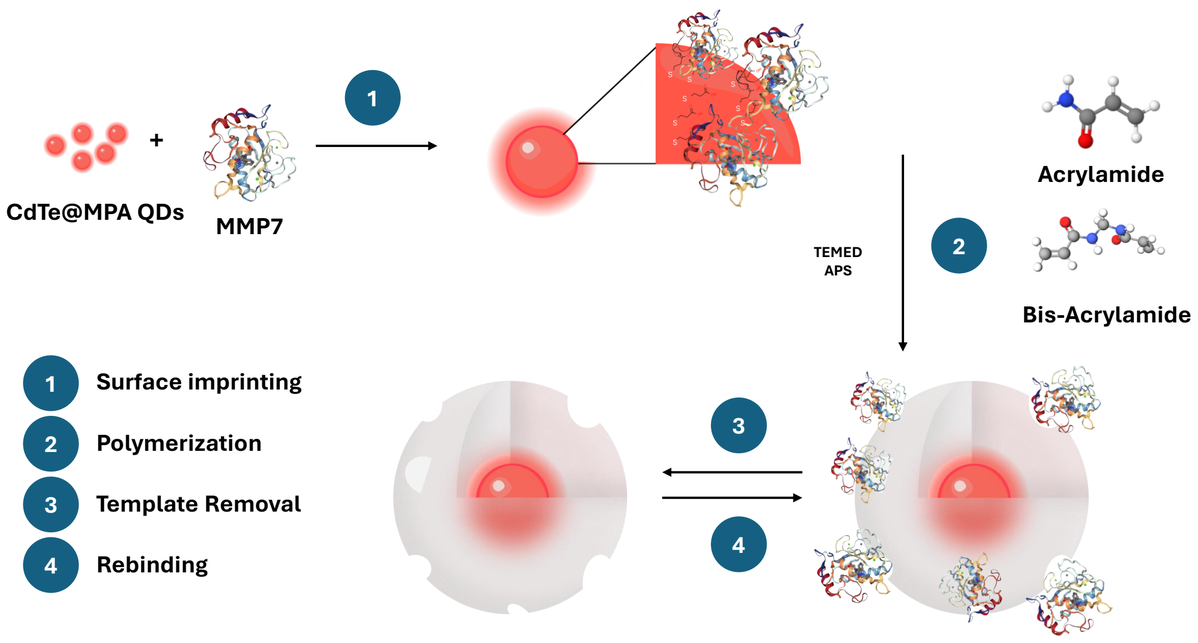
MMP7, also known as matrix metalloproteinase 7, is a biomarker for oncogenic activity in a variety of tumour types. As part of the zinc-dependent endopeptidases group, it can break down practically all protein components found in the extracellular matrix[1]. CdTe MPA-Capped Quantum Dots (CdTe@MPA QDs) are luminescent nanoparticles with exceptional optical features as customized particle sizes and narrow emission spectra. They can be integrated into sensing systems for the sensitive and selective detection of metal ions, biomarkers, and antibiotics[2].

QDs can be functionalized by in situ polymerization, which combines monomers, crosslinkers, and proteins to create recognition cavities. Upon rebinding with the target biomarker, these cavities demonstrate biomimetic recognition sites complementary to the target biomolecule. The presence of the target leads to fluorescence quenching, of the functionalized QDs with MIPs, thus allowing for a simple and straightforward method for the selective quantification of the biomolecule.

Background

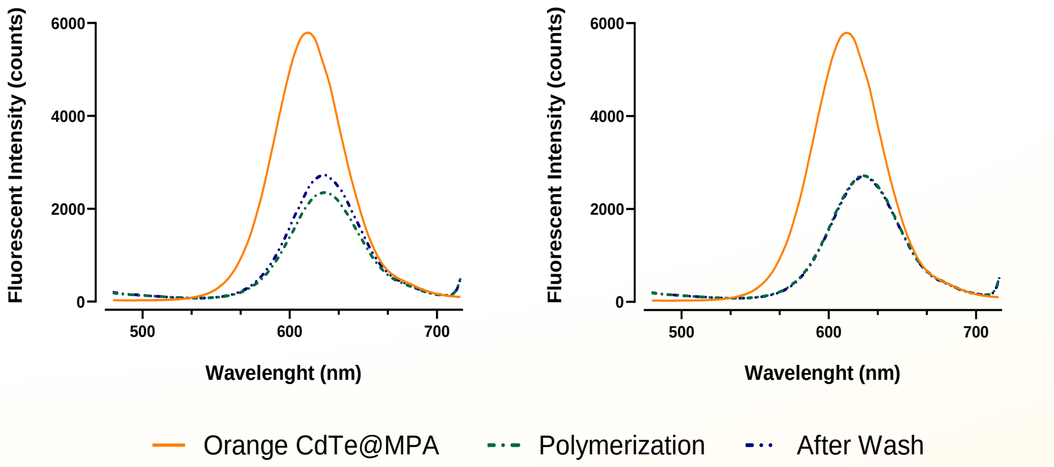
- CdTe@MPA functionalization allows the biomarker to be anchored to the QD, forming a polymer surrounding the QD and the target protein.
- The molecular imprint polymer is formed following the removal of the template protein.
- The MIPS created have recognition sites that selectively bind to the target molecule. These polymers are inexpensive and simple to prepare, providing a stable thermal and pH system in natural conditions.
- The technology is based on fluorescence quenching caused by the target protein, which enables the development of future point-of-care applications.

Methods



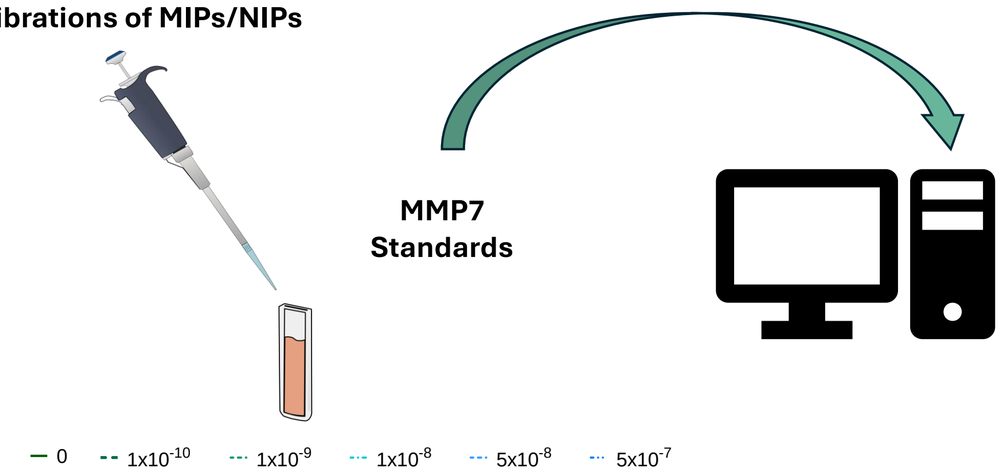
Results and Discussion

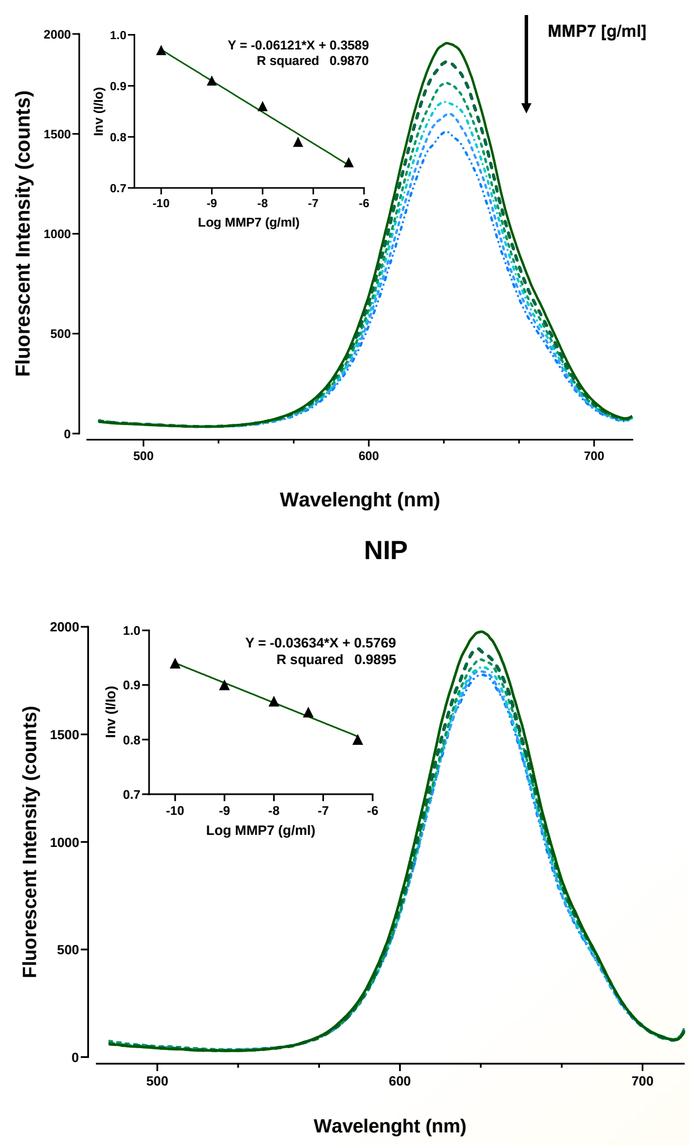
1.Assembly of MIPs/NIPs



Results and Discussion

2.Calibrations of MIPs/NIPs





Conclusions

Quantum dots were successfully functionalized using molecularly imprinted polymers for MMP7 assessment. This form of analytical examination is well-suited to the present surface imprinting technology strategy. MIPs and NIPs follow normal assembly patterns and stay stable during measurements.

Calibration showed that the MIP detects at the first standard concentration of $1x10^{-10}$ g/mL. Overall, the MIPs have binding capacity with the target protein, indicating possibilities for further study into increased sensitivity and inclusion into future point-of-care devices.

References

[1] Meng N, Li Y, Jiang P, et al. A Comprehensive Pan-Cancer Analysis of the Tumorigenic Role of Matrix Metallopeptidase 7 (MMP7) Across Human Cancers. Front Oncol. 2022;12:916907. Published 2022 Jun 17. doi:10.3389/fonc.2022.916907

[2] Safari, Meysam. 'Recent Advances in Quantum Dots-Based Biosensors'. Quantum Dots - Recent Advances, New Perspectives and Contemporary Applications, IntechOpen, 18 Jan. 2023. Crossref, doi:10.5772/intechopen.108205.

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