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## Abstract

Magnetic beads have been widely used in nucleic acid extraction to facilitate rapid diagnostics. However, the recent pandemic highlighted that global supply of magnetic beads reagent can be unreliable; this alone highlighted the urgent need for local suppliers of medical materials. Applied Quantum Materials Inc. (AQM) has developed a suite of proprietary naked (MagDx) and oligo-functionalized magnetic beads (Oligo-MagDx) that efficiently provide nucleic acid extraction. Characterization of AQM's MagDx and Oligo-MagDx using X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), and dynamic light scattering (DLS) analyses provide important insight into their material properties. Extraction performance for SARS-CoV-2 E gene and RdRP gene using MagDx or Oligo-MagDx was examined. The RT-PCR results showed that the MagDx exhibited higher extraction efficiency for both genes compared with the commercial beads. The Oligo-MagDx also showed high extraction efficiency and great test sensitivity, while it can be improved in selectivity for targeted nucleic acid extraction.

## I. Introduction

### Background

- SARS-CoV-2 pandemic highlighted the magnetic bead shortages in Canadian market.
- While magnetic bead technology has advantages for nucleic acid extraction, the efficiency and selectivity can be improved.
- AQM has developed MagDx and Oligo-MagDx that are efficient for nucleic acid extraction.

### Why AQM magnetic beads?

- Our magnetic bead nucleic acid extraction kits are designed to efficiently extract high-quality DNA and RNA from viral transport media and cell suspensions.
- AQM magnetic beads can be applied on both manual and automated platforms.
- Our kits can be customized to address specific customer needs.



## II. Experiments

### Bead characterization

- XRD analysis for crystalline structure identification
- FTIR analysis for surface modification testification
- DLS analysis for particle size distribution determination

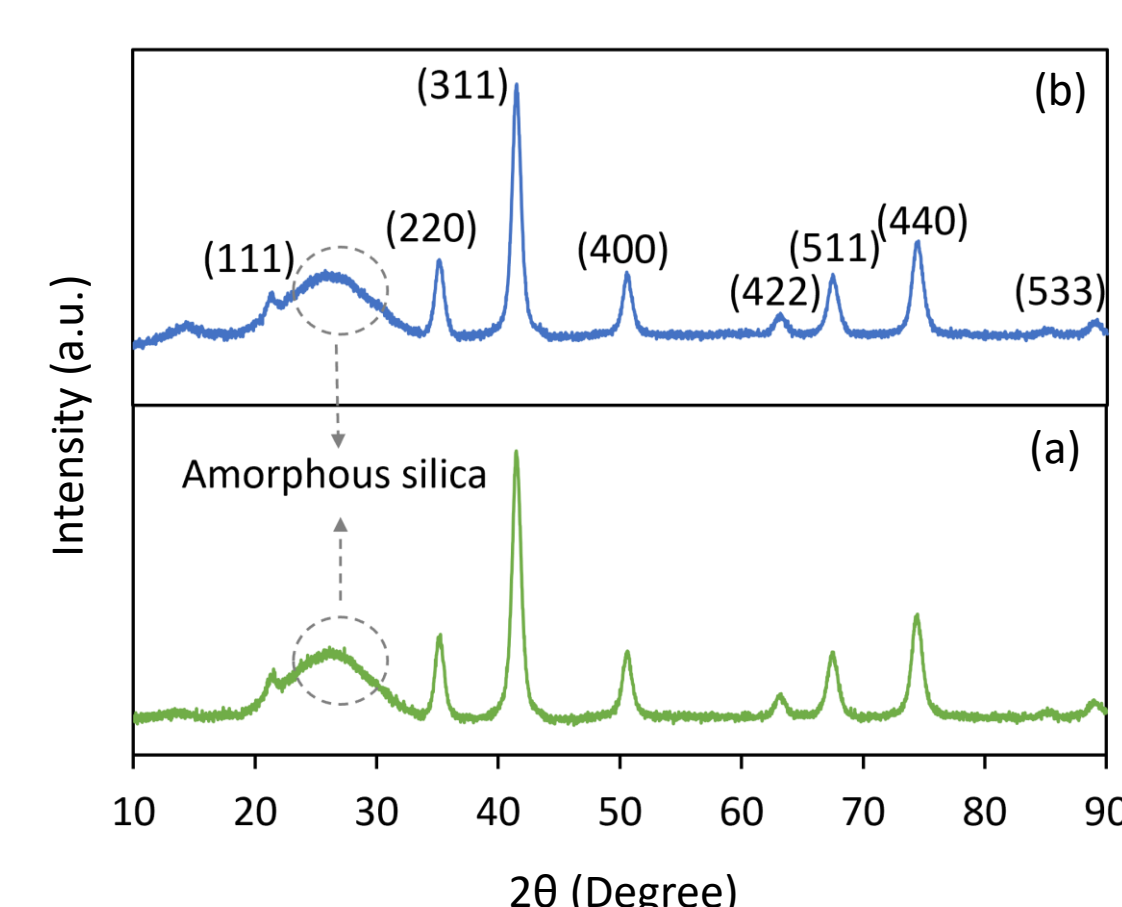
### Nucleic acids extraction

- MagDx for RPP 30 gene extraction  
Input: Hela cells; Platform: Manual.
- MagDx for SARS-CoV-2 gene(s) extraction  
Input: Patient samples; Platform: Automated and manual.
- Oligo-MagDx for nucleic acid extraction  
Input: Human RPP 30 gene and SARS-CoV-2 E gene plasmids;  
Platform: Manual.

### RT-PCR amplification

- To examine the nucleic acid extraction performance.
- A lower Ct value or cycle number suggests a more efficient extraction process.

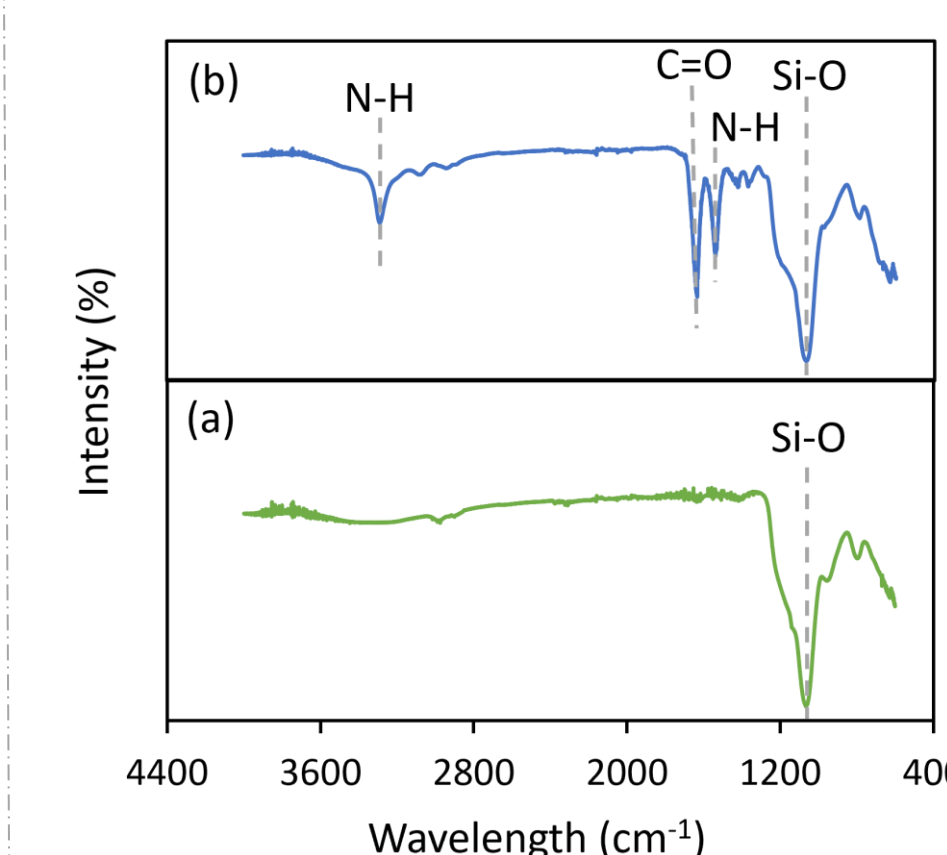
## III. Results: Material properties



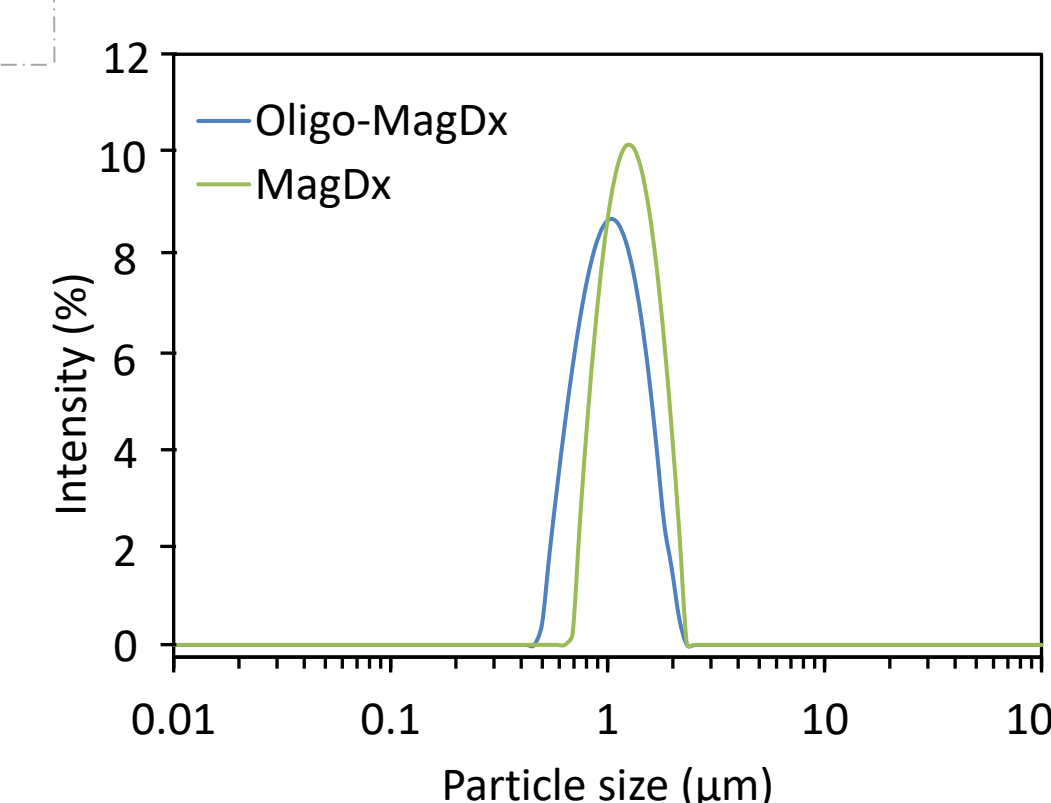
XRD patterns of (a) MagDx; (b) Oligo-MagDx. Both beads are silica coated magnetite materials.

Sample	D <sub>10</sub> (μm)	D <sub>50</sub> (μm)	D <sub>90</sub> (μm)
MagDx	0.84	1.21	1.75
Oligo-MagDx	0.64	0.99	1.52

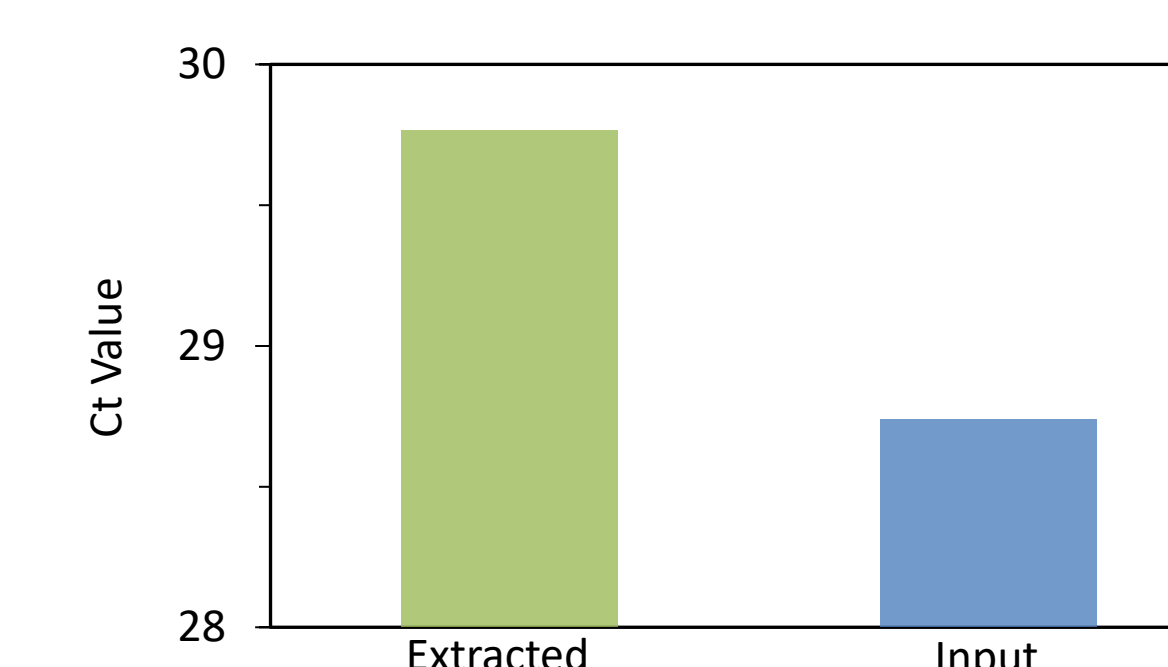
DLS size distribution of MagDx and Oligo-MagDx.



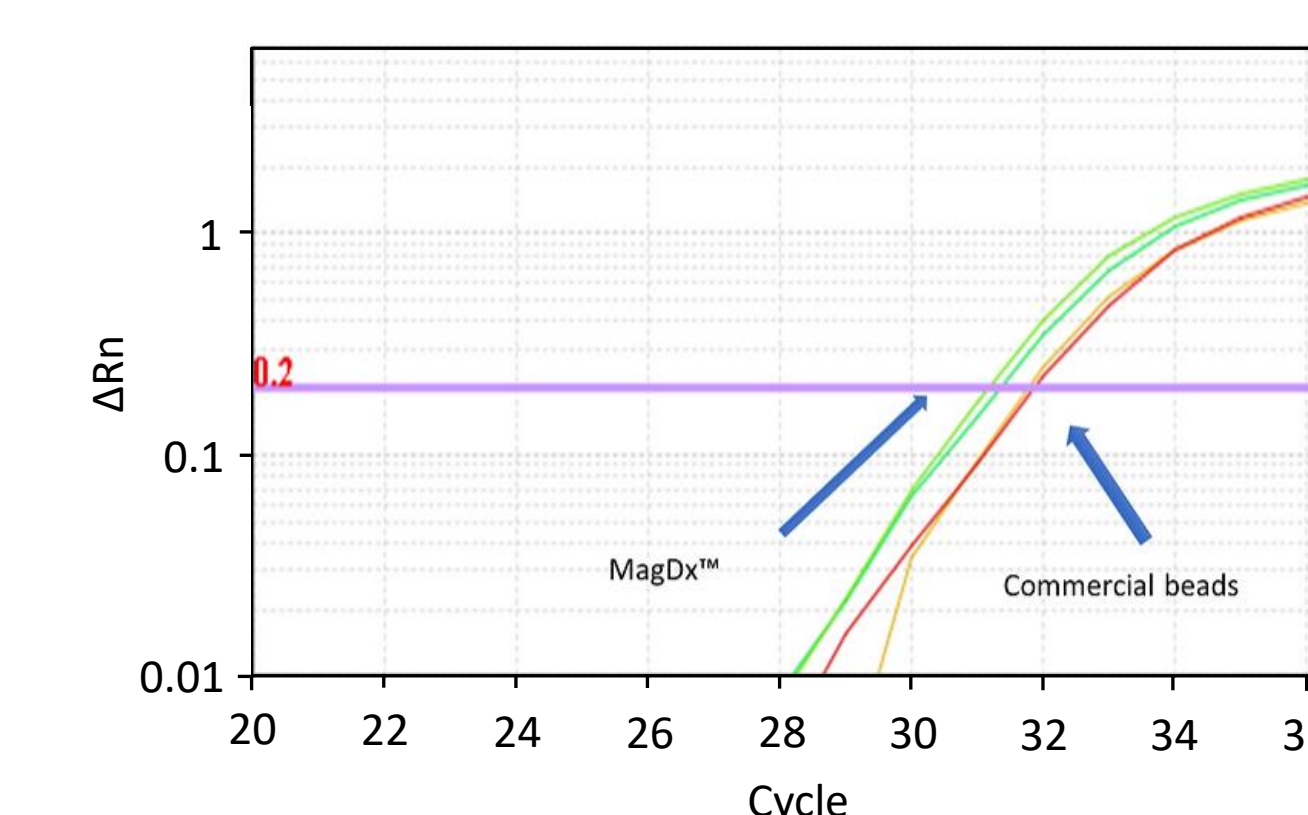
FTIR spectra of (a) MagDx; (b) Oligo-MagDx.



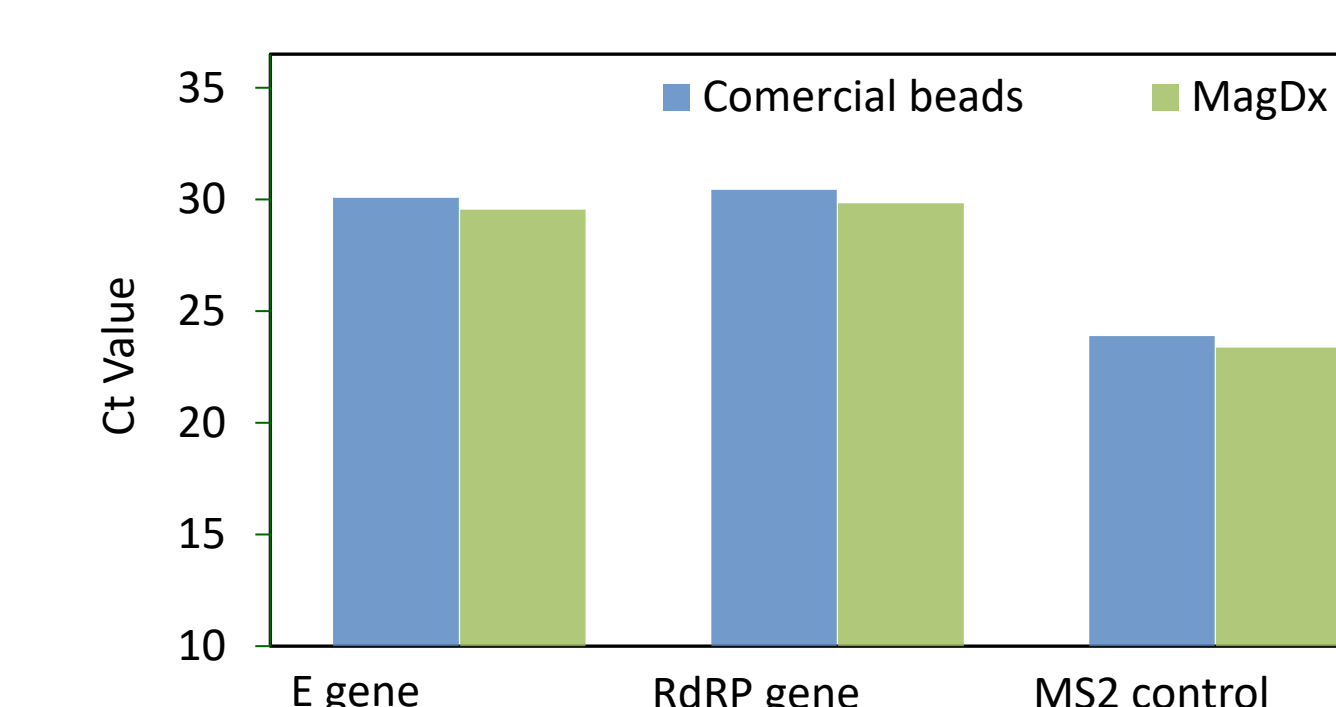
## III. Results: Targeted detection of nucleic acids



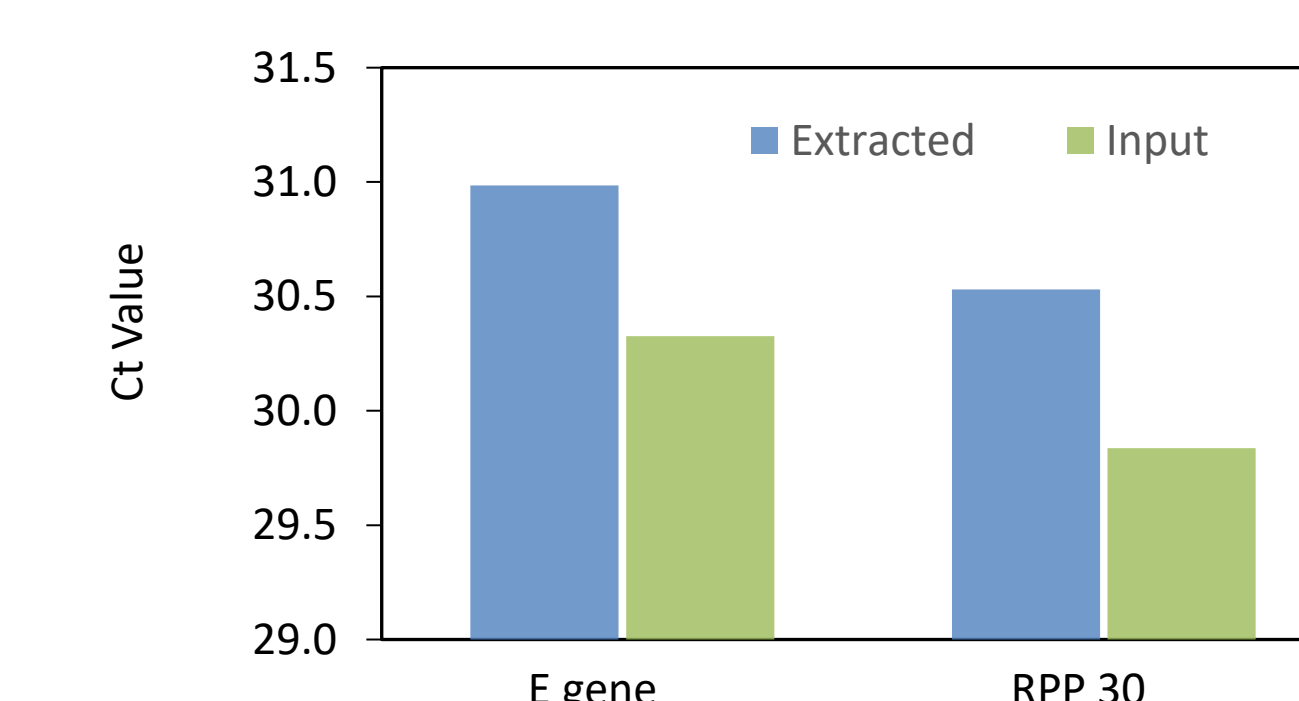
RT-PCR amplification results for RPP 30 gene extracted by MagDx from Hela cells. MagDx showed high extraction performance.



Substitution of MagDx beads on an automated extraction system. MagDx showed superior extraction performance for SARS-CoV-2 RdRP gene.



Manual exaction using commercial and MagDx beads for SARS-CoV-2 E gene or RdRP gene extraction from patient samples. MagDx demonstrated similar or improved extraction efficiency.



RT-PCR amplification results for SARS-CoV-2 E gene and RPP 30 gene extracted by Oligo-MagDx. Oligo-MagDx showed high extraction efficiency.

## IV. Conclusion

- We developed MagDx and Oligo-MagDx silica-shelled magnetic bead kits for targeted detection of nucleic acids.
- Both MagDx and Oligo-MagDx showed high extraction performance for tested genes.
- Our MagDx outperformed a widely-used commercial beads for SARS-CoV-2 genes extraction, on both manual and automated platforms.
- The selectivity of Oligo-MagDx can still be improved.

## V. Reference

- Ji, J., Zeng, P., Ji, S., Yang, W., Liu, H., Li, Y.: Catalytic activity of core-shell structured Cu/Fe<sub>3</sub>O<sub>4</sub>@SiO<sub>2</sub> microsphere catalysts. *Catalysis Today* 2010, 158 (3-4): 305-309.