PORTABLE RAMAN SPECTROSCOPY: AN IMPROVEMENT IN THE RAW MATERIAL QUALITY IDENTIFICATION TESTING METHOD

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Abstract

An external contract laboratory performs the identification testing method of raw materials for a pharmaceutical company. Performing this current activity affects the product release timeframe and represents a high-cost process to expedite the release of the results. It's in the company's interest to improve the current process with a cost-effective analysis by avoiding the time waste associated with sample preparation, processing, and travel time. The portable Raman spectroscopy method testing for raw materials was proposed as a possible option to perform in-house analysis and as a rapid data acquisition tool. Three raw materials were analyzed using the current process and the Raman method to compare the cycle time of each activity. This research showed that using portable Raman spectroscopy is an effective way to perform the identification testing of raw materials by reducing cost, lowering cycle time, and improving process results in one day instead of one week.

Introduction

A pharmaceutical company is allocating its resources to finishing its Phase 3 clinical trial of the extended-release tablets and starts the manufacturing operations as soon as possible. It has been determined that the Quality Control Lab needs to improve its testing operation to a more competitive and lean sustainable process. It was observed that an identification test is required for each container of raw material received used in the manufacturing process of extended-release tablets, which now is an annually high-cost activity that requires the services of an external contractor company. To improve the identification testing, the portable Raman spectroscopy method would be an affordable option to reduce cost and cycle time. By implementing this method, the testing could be performed by the company's analysts, doesn't require an external contractor, and the process can be validated before the manufacturing operations for the extended-release tablets start.

Background

Raman spectroscopy is particularly effective for identity testing in analytical characteristics because of its high degree of selectivity. Every chemical compound with covalent bonds produces its characteristic pattern of Raman shifts, which can chemically fingerprint and identify the compound [1]. The idea of testing the sample at its origin minimizes the number of samples taken, sampling error, labeling error, potential worker exposure, and so on, and allows for increased efficiency when testing multiple drums and batches. Unlike laboratory testing where standards are prepared and tested along with the sample, portable methods rely on stored reference standard spectra for sample identification, and evaluation of these libraries for sustainability and robustness is critical to the long-term success of material identification[2].

Figure 1
Thermo Scientific TruScan Raman Equipment [3]

Problem

The company intends to implement a cost-effective quality Raman spectroscopy method to improve the identification testing analysis of raw materials at the company's QC Lab, allowing for processing results in 24 hours instead of 7 days. Moreover, reduce 60% of the annual cost for ID testing per container using the portable Raman method with the Truscan RM equipment.

Methodology

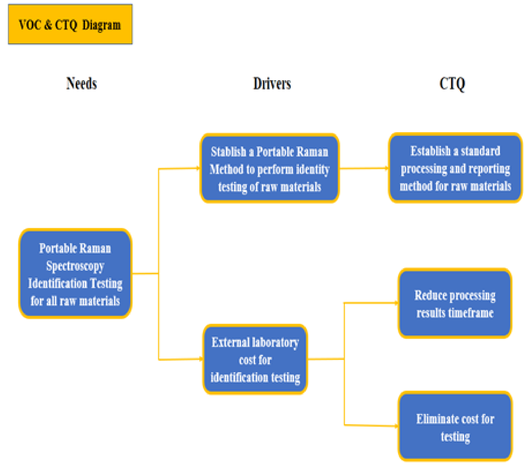

Figure 2
VOC & CTQ Diagram

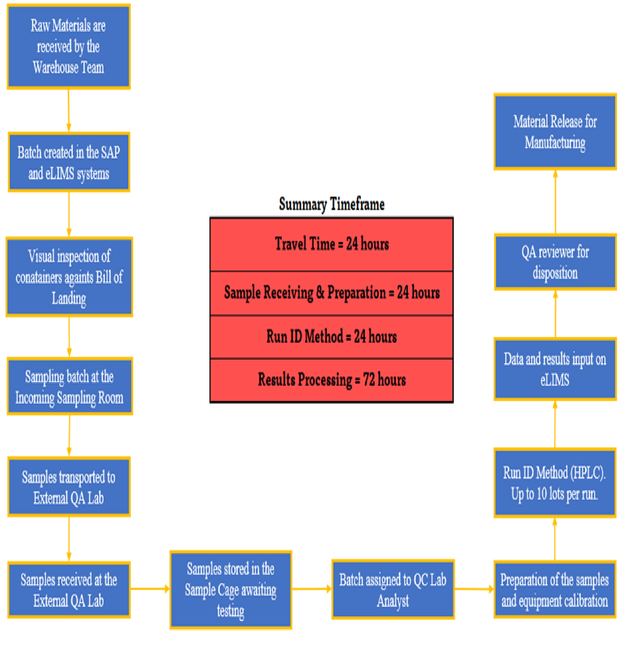

Figure 3
Current State Flow Chart Diagram

Results and Discussion

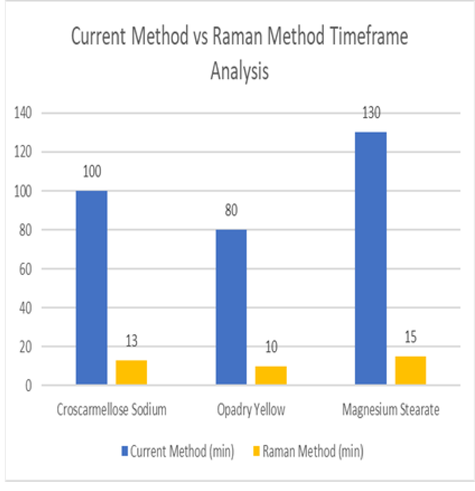

Figure 4
Current Method vs Raman Method Timeframe Analysis

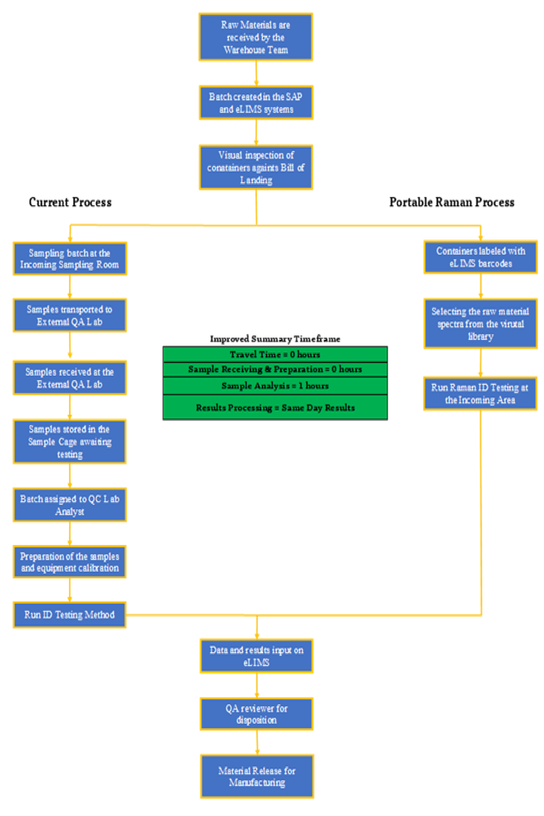

Figure 5
Current Process vs Portable Raman Process Flowchart Diagram

Table 1
Total Cost per sample

Quality Control Activities	Current Cost (per sample)	Raman Cost (per sample)
Incoming Activity: 1. Container identification & sample preparation 2. Sample extraction per container 3. Systems batch processing (SAP, Logbooks & eLIMS)	$18.64	$13.15
External Lab Testing Activity: 1. Sample and documentation receiving 2. Run ID Testing and result verification 3. Results processing (ELIMS)	$23.97	$0.00
HDPE Containers & Labels	$1.48	$0.00
Sample Delivery	$4.50	$0.00
Total	$48.59	$13.15

Conclusions

The technology's specificity for a wide range of materials, its ease of method development and validation, and the ability to directly transfer methods between instruments enable handheld Raman spectroscopy to both improve the quality of raw materials testing while reducing cost [2]. The portable Raman method is a non-invasive testing procedure with less risk of cross-contamination of materials, and it can be performed outside an external laboratory setting like the Incoming Sampling Area. Testing materials without removing samples from packaging is valuable for the company's financial goals, saving time and resources. Moreover, with no associated cost related to sample preparation, travel time, and results processing, the future manufactured lots can be released on time. This testing improvement method reduced the processing timeframe from 144 hours to 24 hours.

Future Work

This project will establish the possibility of performing testing that once occurred in the laboratory and is now executed in the field. With this type of continuous improvement-based research, new technologies can have the opportunity to perform feasibility studies to have a streamlined process in the company's operations.

Acknowledgements

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References

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[3] Thermo Scientific. “Thermo Scientific TruScan RM Next Generation Handheld Raman for Raw Material Identification.” [online document], 2010. Available: https://static.thermoscientific.com/images/D01609~.pdf [Accessed: September 23, 2021].