Repeatability Analysis of Microfluidic Devices using Raman Spectroscopy

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Abstract—This paper presents the repeatability analysis of Microfluidic based biosensors using Raman Spectroscopy. This work also aims the removal of Diesel/Biodiesel and its different compositions from SiO_2 surface which is a common material for most of the microfluidic devices due to its hydrophilic nature. The removal method may be used for cleaning of different microfluidic devices made of glass/SiO_2 such as Micro-Viscometer, Density-meter *etc.* for the different characterization of diesel/bio-diesel in its different compositions.

Keywords: Biosensors, Microfluidics, Diesel/Biodiesel

1 Introduction

As the fossil fuels are depleting with time, the concerns and research work in the area of renewable energy is growing; thereby providing ample scope for the production of biofuels [1, 2]. Microfluidic devices for diagnostics have gained significant attention of scientific community since last few years because of many advantages i.e. low-cost, compatibility with most of chemical and biochemical reactions and possibility of fluid-flow through capillary action without any external pumping [3-6]. Since, Microfluidic devices are used at a small scale therefore contamination has a significant impact on device output [7]. So cleaning of microfluidic devices plays a very important role for better device performance.

2 Aim of the Study

Biodiesel is an alternative for diesel fuel that is obtained by trans-esterification of vegetable oils or other materials that are largely composed of tri-glycerols. Biodiesel is composed of fatty acid chains that are chemically bonded to one methanol molecule. This work aims the removal of Diesel/Biodiesel and its different compositions from SiO_2 surface which is a common material for most of the microfluidic devices because of its hydrophilic nature. The removal method may be used for cleaning of different microfluidic devices made of glass/SiO_2 such as Micro-Viscometer, Density-meter *etc.* for the different characterization of diesel/bio-diesel in its different compositions.

3 Methods

The material selection for fluidic channel plays an important role in Micro/Nano fluidics. To assist the filling of microchannel without any external pumping, SiO_2 as a fluidic channel wall material is used due to its hydrophilic behavior [8]. For the current study, the pieces of oxidized silicon wafers are taken and dipped into diesel/ biodiesel and its different compositions for 1 minute. Raman spectra are taken before and after cleaning of different pieces of oxidized silicon wafers dipped into different solutions (i.e. diesel/biodiesel and its different compositions) using different chemicals such as acetone, methanol etc.

4 Results

Fig. 1 shows Raman Signature of oxidized silicon wafer dipped in Biodiesel (B_{100}) at different wavenumbers before cleaning of the sample. The first set of pieces of oxidized silicon wafers are dipped in trichloroethylene (TCE) and agitated in ultrasonic

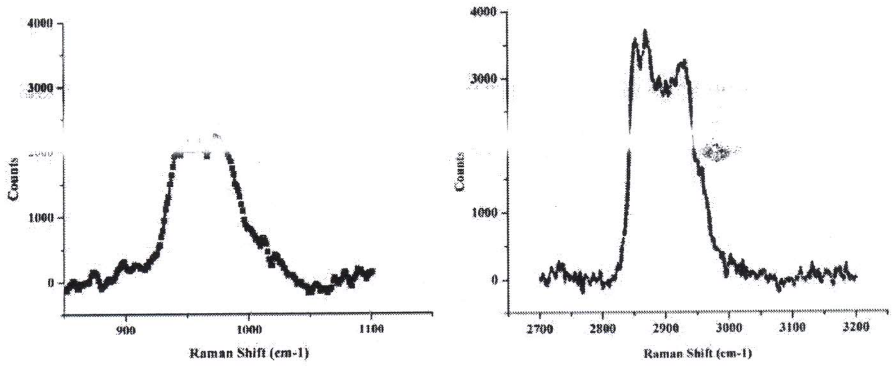
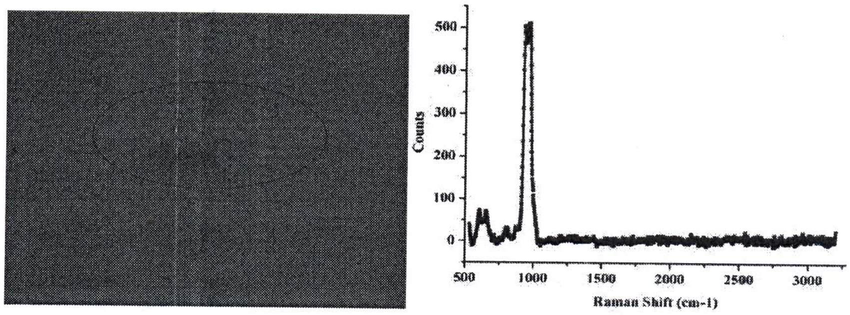


Fig. 1. Raman Signature of Biodiesel (B_{100}) at different wavenumbers

agitator for about 2 minutes and after that samples are kept in acetone and agitated for another 2 minutes. Fig. 2 (a, b) indicates that few traces of Biodiesel are still left after the chemical treatment using acetone. Raman signature (Fig. 2 (b)) shows different peaks (laser of 532 nm is used) between 500-1050 cm^{-1} Raman shift which confirms the presence of different bonds such as CH_3 rocking, C-C stretching, C-O stretching (Fig. 1). The second set of pieces of oxidized silicon wafers are taken and dipped in Methanol for 15 seconds, 30 seconds and 1 minute. After Raman spectroscopy analysis, it is observed that 1 minute dipping time and agitation in Methanol completely removes the diesel/ biodiesel and its different composition from SiO_2 surface.



(a) (b)

Fig. 2 (a). Optical image of after chemical treatment (Acetone) of Oxidised Silicon sample showing traces (encirciled area) of Diesel and Biodiesel **(b).** Raman signature of Oxidized silicon sample after the chemical treatment using acetone to remove Biodiesel (B_{100})

5 Conclusion

The unique method for removal of Diesel/Biodiesel and its different compositions is developed to reuse the different microfluidic devices and also removal time is optimized. The removal method may be used for cleaning of different microfluidic devices made of glass/SiO_2 such as Micro-Viscometer, Density-meter etc. for the different characterization of diesel/bio-diesel in its different compositions.

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