Paper No: PU-SOE- ECE - 09

Handheld and 'Turnkey'3D printed paper-microfluidic viscometer with on-board microcontroller for smartphone based biosensing applications

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Abstract

Herein, Microfluidic Paper-based Analytical Devices (μPAD) strips, also called microstrips, have been fabricated using a fused-deposition modeling (FDM) based 3D printer. A polycaprolactone (PCL) filament on a chromatography paper was harnessed to create hydrophobic boundaries of a microchannel. A pair of screen-printed electrodes, with known separation, were integrated on the microchannel to measure the time taken for fluid automatically. A mini electronic sub-system, amenable to connect with an android smartphone, consists of an easily programmable microcontroller, Bluetooth module and voltage booster circuit. The pluggable-and-playable disposable microstrip was utilized to measure the viscosity of various biological samples with an accuracy of >92% with respect to a benchtop viscometer. In particular, the protein denaturation of Bovine Serum Albumin (BSA) and Lysozyme, and viscosity variation of human saliva have been observed. With a competency to measure the viscosity between 0.5 cP to 10 cP, platform cost of <US$ 8 and a cost-per-test of less than US$ 0.02, the present device has a strong potential to be employed as a personalized gadget for various viscosity dependent measurements.

Key words:
Microfluidic paper-based analytical devices (μPAD); 3D printing; Polycaprolactone; Microstrips; Microviscometer

Publication Details:

Journal Name	Vol.	Month & Year	Page No.	Publisher	Scimago Ranking
Analytica Chimica Acta	1153	Apr, 2021	NA	Elsevier	Q1