INNOVATIVE IMPACTION PLATE FOR REAL TIME CASCADE IMPACTOR WITH AUTONOMOUS CLEANING

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Abstract

- SUMMARY:

This paper presents an original cleaning system for impaction plates dedicated to cascade impactor previously developed in our laboratory for real time measurements of aerosol [1]. These impaction plates are equipped with surface acoustic wave (SAW) sensors based on a delay line configuration for measurement of PM10 and PM2.5. In order to avoid the sensitivity loss of the SAW sensors with particles accumulation and to increase the sensors lifetime, we propose to test and take advantage of the capabilities of Rayleigh waves on 128∘YX-Lithium Niobate to achieve the displacement of microparticles apart from the sensitive zone of the sensor.

- MOTIVATION and RESULTS:

The particulates matters PM10 and PM2.5 are reported as dangerous for human health [2]. Commercialized systems for monitoring air quality are very expensive and cumbersome. An innovative system based on Love wave propagated on SAW sensors built on quartz substrate with additional silica guiding layer has been previously fabricated in our laboratory. This system achieves the separation and measurement of PM10 and PM2.5 in real time with a custom-designed cascade impactor operating at 3 Lpm flow rate. The innovative feature of the latter is that the impaction plates are replaced by SAW sensors [1]. These sensors are based on a delay line configuration using IDTs consisting of double finger 200 nm thick aluminium electrodes on quartz substrates. The particles are collected on the different stages of the system and their mass are measured in real time (figure 1). Despite the efficiency of such a system, the accumulation of particles on the SAW sensors causes a decrease in sensitivity up to the complete loss of the signal. In order to overcome this problem, investigations have been carried out to remove particles from the sensors sensitive zone. In that purpose, we chose to exploit the high electromechanical coupling factors k2 (from 7 % to 20 %) and low propagation and insertion losses of LiNbO3 [3]. Thus, we have shown that the use of a Rayleigh wave based delay line on 128∘YX-LiNbO3 substrate allowed to remove particles from the surface of the substrate. The displacement is achieved by applying a radio-frequency signal with a power level higher than 30 dBm at approximately 113 MHz.

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The setup designed for driving the SAW delay line with high RF power is described in figure 2. Particles with diameter smaller than 2.5 μm originated from the fume of a burning candle have been moved out of the acoustic track after 30 s at 30 dBm (figure 3). Particles of silicon carbide (SiC) smaller than 5 μm have also been tested and successfully removed fromthe acoustic track after 20 s at 31 dBm (figure 4). These results pave the way for the realization of new self-cleaning impactors using sensors based on LiNbO3 substrates.

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