An Ultra-Low Current Meter for Aerosol Detection

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ABSTRACT

An ultra-low current meter (ULCM) is used for charged aerosol measurement. In this work, a prototype of the ULCM was designed, built and experimentally tested. Commercially-available operational amplifiers were used to construct the meter. The range of the current measurement of the ULCM was from 1 to 500 pA, corresponding to number concentrations of aerosol particles in the range of 10^{11} - 10^{14} particles/m^3. The ULCM was relatively simple, inexpensive and compact. The ULCM's performance was evaluated with a high-impedance current source and compared with a commercial electrometer, Keithley model 6517A. It was found to be in accord with theoretical predictions and close agreements with the commercial instrument. The prototype meter was proven to be promising for aerosol detection.

Key words: Aerosol, Electrometer, Low current, Prototyping

INTRODUCTION

Airborne particles have significant effects on human health and the Earth's climate because they have a relatively long residence time in the atmosphere and are able to penetrate deep into human lung. Measurement and classification of airborne particles' size have become an important issue. For this purpose, aerosol-size analyzers based on electrical mobility determination were developed to measure size distribution in sub-micrometer range (Intra, 2006). For most electrical mobility analyzers (EMA), an aerosol detector in the form of an ultra-low current meter (ULCM) is required to sense the presence of these particles. The ULCM is normally employed to measure the exceedingly small amount of electrical current associated with the charged particles collected on an electrode ring of the sizing instruments. If the aerosol charge distribution is known accurately in terms of the number of electrical charges per particle and the fraction of particles which are charged as a function of particle size, it is possible to determine both the size of the particles being measured as well as the total number concentration of the particles. The elec-