The interest in airborne particulate matter monitoring has steadily gained interest due to effects of these aerosols on both climate and health. From a health perspective, epidemiological studies have established a direct correlation between ambient particle number density and mortality rates. The mechanisms surrounding these negative health outcomes are still poorly understood. From an atmospheric perspective, aerosols affect precipitation patterns, heating and cooling cycles, and visibility. In this presentation, a microfluidic systems that allow for measurement of particle composition and biological reactivity will be presented. Aerosols exhibit high temporal and spatial variability, making extended, routine analyses across broad geographic regions a necessity. Current composition monitoring techniques include filter extraction analyzed offline with ion (IC) or gas chromatography (GC), the particle-into-liquid-system (PILS) coupled directly to IC, and the aerosol mass spectrometer (AMS). None of these techniques possess the attributes needed for routine, widespread monitoring – inexpensive instrumentation, rapid analysis (< 5min), and/or the ability to monitor many species simultaneously. The current presentation will first discuss work focused on interfacing microchip capillary electrophoresis (MCE) with a small particle sampler to provide a device capable of inexpensive, routine aerosol monitoring. The system can measure common anions with detection limits of 10 nM and provide high resolution of critical aerosol components. The second part of this talk will focus on measuring the ability of particulate matter to react with model antioxidants using an microfluidic electrochemical sensor. The system has the ability to provide the highest temporal resolution measured to date for particle reactivity. Finally, the use of paper-based analytical devices for the measurement of particle composition will be discussed with an emphasis on detecting particulate metals in occupational health settings. Paper-based analytical devices are of significant interest in this application because they can detect low levels of metals while costing less than $0.02 for each assay.