The Effects of Mainstream and Sidestream Environmental Tobacco Smoke Composition for Enhanced Condensational Droplet Growth by Water Vapor

X. Tang[1,3], Z. Zheng[2,3], H. S. Jung[2,3], A. Asa-Awuku[1,3]

[1]Department of Chemical and Environmental Engineering, University of California, Riverside, California, 92521, USA
[2]Department of Mechanical Engineering, University of California, Riverside, California, 92521, USA
[3]Center for Environmental Research and Technology (CE-CERT), University of California, Riverside, California, 92507, USA
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Presenting author email: akua@engr.ucr.edu

Adverse health effects from particulate matter (PM) are caused by the deposition of particles in the respiratory tract during inhalation. The water vapor uptake by hygroscopic particulate components can alter dry particle size and deposition efficiencies (Londahl et al. 2009). Therefore, the dose and deposition site of these aerosols are influenced by the growth of the particles. Relative humidity in the lung is estimated at 99.5% RH (Anselm et al. 1990), and more recent work has calculated instantaneous values in the supersaturated range (up to 104% RH) (up tp 104% RH;Varghese and Gangamma 2009; Longest et al. 2010). At large RH, enhanced condensational growth (ECG) may occur, droplets may form (Longest et al. 2010) and dry particles will effectively behave as cloud condensation nuclei (CCN) within the respiratory system. The following study explores the aerosol composition of inhaled cigarette smoke in relation to ECG and CCN properties.

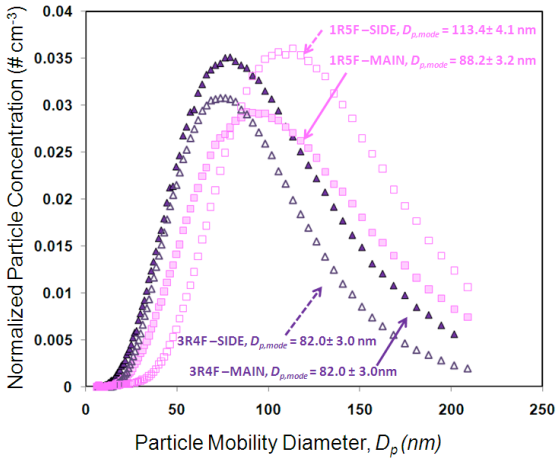

Figure 1. Particle Size distributions from mainstream and sidestream ETS. 1R5F cigarettes form particles of larger modes in both mainstream and sidestream ETS.

Although tobacco smoke is well known for its adverse health effects, the hygroscopicity and droplet growth properties have not been thoroughly explored. In this study, cigarette smoke is further characterized and several state-of-art analysis techniques are applied to understand the effects of particle hygroscopicty on particle deposition. Two types of research cigarettes are tested using a Walton Smoking Machine and two kinds of smoke are produced during smoking: main stream and side stream. In addition to tar-like-materials, tobacco smoke contains soluble organic materials that influence particle water uptake and droplet formation during inhalation. Online and offline analysis are combined to analyze the aerosol phase of cigarette smoke. The two types of cigarettes produce aerosols of similar hygroscopicity (κ_{eff}~0.15) in main and side stream smoke. The elemental composition and oxidation state of cigarette smoke is examined with high resolution data analysis by an Aerodyne High Resolution (HR) Time-of-Flight Aerosol Mass Spectrometer (HR-ToF-AMS). The oxygen-to-carbon ratio from HR data suggests that more oxidized components are present in mainstream smoke. Water soluble organic carbon is characterized by offline filter measurements, as well as elemental carbon/ organic carbon (EC/OC). EC/OC measurement shows that the majority of particles in both main and side stream smokes are organic compounds. Despite of diverse physical compositions of tested cigarettes, main and side

Table 1: Aerosol activation and average single-parameter hygroscopicity data

Type	stream	$\kappa_{eff,\,avg}$
1R5F	main	0.15 ± 0.01
	side	0.15 ± 0.01
3R4F	main	0.15 ± 0.01
	side	0.15 ± 0.02

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