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Use of Fluorescence Probe Spectroscopy to Characterize RH-Dependent Phase Transitions and Physicochemical Properties of Respiratory Aerosols

Understanding the viability of viruses contained in respiratory particles and the connections between this viability and the relative humidity (RH)- mediated physicochemical properties of the aerosols themselves is critical to mitigate respiratory disease transmission. Here we present the use of fluorescence probe spectroscopy to investigate the phase state of model respiratory particles. In this technique, fluorescent molecules are incorporated into the particles of interest and their polarity-dependent emission properties are used to determine particle phase state. Particles consisting of mucin/salt mixtures, a growth medium, and simulated lung fluid were studied across an RH range of 30-80%. Phase separation between the organic and inorganic constituents was observed at an RH that was dependent on the chemical composition of the particles. The use and advantages of a range of different probe molecule classes, including solvatochromic and excited state intramolecular proton transfer will be discussed. Furthermore, we demonstrate that volatilization of probe molecules and subsequent condensation can be used to incorporate the molecules into preexisting unlabeled particles. This methodology enables the study of real exhaled respiratory particles using fluorescence-based measurement techniques. Finally, we discuss the outlook for fluorescence probe spectroscopy in the field, including its use to investigate other physicochemical properties such as pH and viscosity as well as its application more chemically-complex systems such as real respiratory and environmental aerosols.

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