Determining Glass Transition Temperatures of Individual Isoprene-Derived Secondary Organic Aerosol Particles

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Abstract Number: 622
Working Group: Instrumentation and Methods

Abstract

The ability of an atmospheric aerosol particle to take up water or to participate in heterogeneous reactions is highly influenced by its phase state – solid, semi-solid, or liquid. The changes in phase state can be predicted by glass transition temperature (T_g), as particles at temperatures below their T_g will show solid properties, while increasing the temperature above their T_g will allow for semi-solid and eventually liquid properties. Historically, measurements of the T_g of bulk materials have been studied in order to model the phase states of aerosols in the atmosphere; however, these methods only permit an estimation of aerosol Tg based on their bulk chemical composition. Determining the T_g of individual particles will allow for more accurate model predictions of aerosol phase state. Herein, we apply a recently developed method utilizing a nano-thermal analysis (nanoTA) module coupled to an atomic force microscope (AFM), to determine the T_g of individual secondary organic aerosol (SOA) particles generated from the reactive uptake of isoprene-derived epoxydiols (IEPOX) onto acidic ammonium sulfate aerosol particles. NanoTA works by using a specialized AFM probe which can be heated while in contact with a particle of interest. As the temperature increases, the probe deflection will first increase due to thermal expansion of the particle followed by a decrease at its melting temperature (T_m). The T_g of the particle can then be determined from Tm using the Boyer–Beaman rule. We compare the T_g of the SOA particles formed from IEPOX uptake onto ammonium sulfate particles with different initial aerosol pH values, as well as under a range of oxidant exposure conditions. Our measurements will allow for more accurate representations of the phase state of aerosols under a range of atmospheric conditions.

AAAR 2022