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Diels-Alder-Reactions in nanometer aerosol particles

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To predict the composition of the atmosphere in the context of understanding global climate change, knowledge about the formation of new aerosol particles and their growth is increasingly important. Nanometer-sized aerosol particles are initially formed by nucleation and then grow under the influence of organic molecules. Especially the small particle embryos form a unique chemical environment at the nanoscale, as they could influence chemical reactions due to their size-dependent physical properties. For example, smaller particles have higher internal pressure (Laplace pressure), which could influence reaction rates and equilibrium status in pressure-dependent reactions. In general, bond-forming chemical reactions should be favored at higher pressure, so they gain importance in small particles. Therefore, particle size-dependent chemical reactions could play a crucial role in the life cycle of atmospheric aerosols. Here we present results on Diels-Alder reactions with suitable dienes and dienophiles in nano-aerosol particles, which represent a pressure-sensitive chemical system. N-methylmaleimide as a dienophile in the particle phase and cyclopentadiene as a diene in the gas phase were chosen for their reactivity, volatility, and detectability. We study the growth and behavior of the aerosol particles and the product formation. The analysis is performed with Scanning Mobility Particle Sizer Systems (SMPS) and a GC-MS system with thermal desorption.