

## Temperature-induced reduction of the work function of submicron aerosol particles and its implication on thermionic particle charging

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Aerosol particles have been found to exhibit very high charge levels at elevated temperatures (Schiel et al., 2003). The reason for this enhanced charging was supposed to be due a work function reduction. However, measurements in a high temperature tube furnace showed that the particle charging by direct electron emission is superimposed by diffusional charging with negative ions originating from the tube wall. In fact, at very high temperatures the polarity of the particle charge changes from positive to negative. Therefore, the reliability of the effective work function as deduced from the particle charge was rather uncertain so far. Therefore, photoemission spectroscopy was employed to measure the work function of aerosol particles as a function of temperature for conditions where thermoemission from the walls was negligible. Since the particles were between 70nm and 220nm they exhibit solid state behaviour of the bulk material. In addition, also electrostatic corrections accounting for the image charge correction for very small sizes were not necessary (Müller et al., 1988).

Aerosol particles of Pt and TiO<sub>2</sub> were produced by spark discharge and thermal decomposition, respectively, and size classified in a Differential Mobility Analyzer (DMA). The negatively singly charged particles entered the UV illumination chamber which was heated to temperatures up to 700°C. From a broad band UV source monochromatic a narrow wavelength was selected with a monochromator and the resulting photon flux was measured with a photomultiplier tube (PMT). Using a combination of electrostatic precipitator (ESP) and Condensation Particle Counter (CPC) single electron counting efficiency was obtained.

In Figure 1 the results for platinum and titanium dioxide particles are shown. For temperatures above 500°C thermionic emission from the walls of the illumination chamber overwhelm the aerosol charge rendering direct photoelectric measurements of the particle work function impossible. However, for the determination of the aerosol charge at high temperatures it was found that

for the used quartz tubes electron emissions from the walls could be neglected at least up to 800°C.

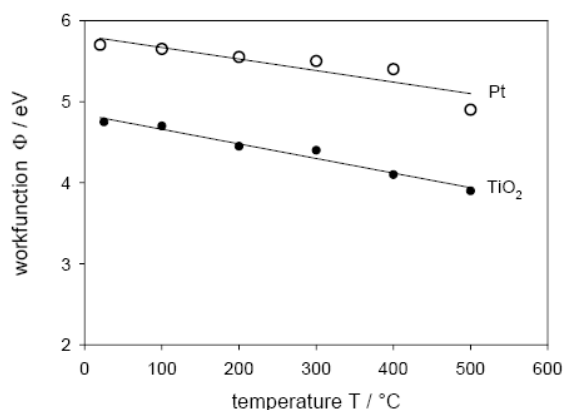


Figure 1. Temperature-induced reduction of the work function of Pt and TiO<sub>2</sub> nanoparticles

Therefore, the work function was extrapolated to 800°C and the resulting particle charge state was calculated using a model outlined in Schiel (2007). The calculated and the measured particle charge agree very well so that the results of the work function determination and the charge measurement corroborate each other. Thus, the work function behaviour allows to predict the charging behaviour of aerosol particles at high temperatures for cases where secondary effects such as thermionic emission from the walls are insignificant.

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