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Characterization of Collected Aerosol Carbonaceous Particles using Atomic Force Microscopy

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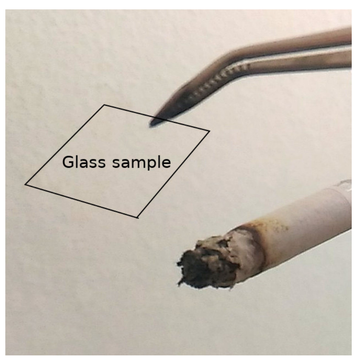
Introduction & Motivation

Atomic Force Microscopy (AFM) is common method for topography measurements of various samples including carbon containing nanomaterials or collected aerosol particles. Employment of AFM for collected aerosol material is advantageous because of ambient measurement conditions, there are no problems with low pressure, sample charging or contamination that can occur during electron microscopy. However, for such measurements, good adhesion of collected aerosol particles to the substrate is crucial. Selected substrate for collection of aerosol particles and other aspects of collecting proccess have impact on the final result. The aim of this work is to investigate possibilities of topography measurements of individual carbonaceous particles using AFM.

Particles Generation & Collection

Three different aerosol sources were used for particle generation: a) cigarette, b) common butane lighter and c) inverted soot generator from Argonaut Scientific that used a downward-flowing open-tipped diffusion flame sustained by 70 sccm propane and 8 SLM air flow. Particles were collected on glass substrates without any intended size pre-selection. For first two samples, the situation for collecting of particles is on first two pictures below. First sample was exposed for 4 minutes to cigarette smoke and second sample for 15 seconds to the lighter. Collection of particles from inverted soot generator proceeded inside generator exhaust tube in distance of 1.5 m from the generator, where the glass substrate was situated and exposed for 10 min to operating inverted generator.

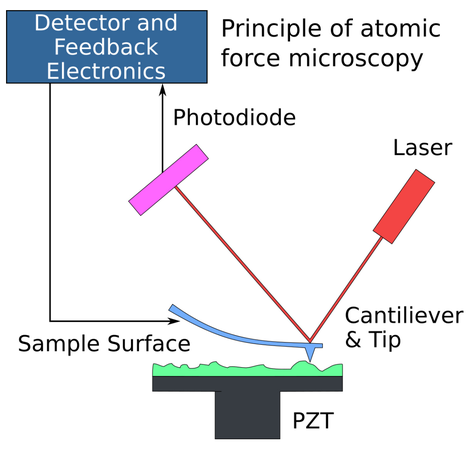


a) Cigarette

b) Butane lighter

c) Inverted generator

AFM Measurement



AFM measurements were performed using Bruker Dimension Icon microscope. First sample (cigarette) was measured in tapping mode with RTESPA-150 AFM probe. Second sample (lighter) was measured in two modes: (i) PeakForce tapping, (ii) Tapping mode, both with ScanAsyst-Air AFM probe. Sample from inverted generator was measured in PeakForce tapping mode with ScanAsyst-Air AFM probe. AFM data were evaluated in Gwyddion (http://gwyddion.net/) - free AFM data evaluation software.

ACKNOWLEDGEMENT
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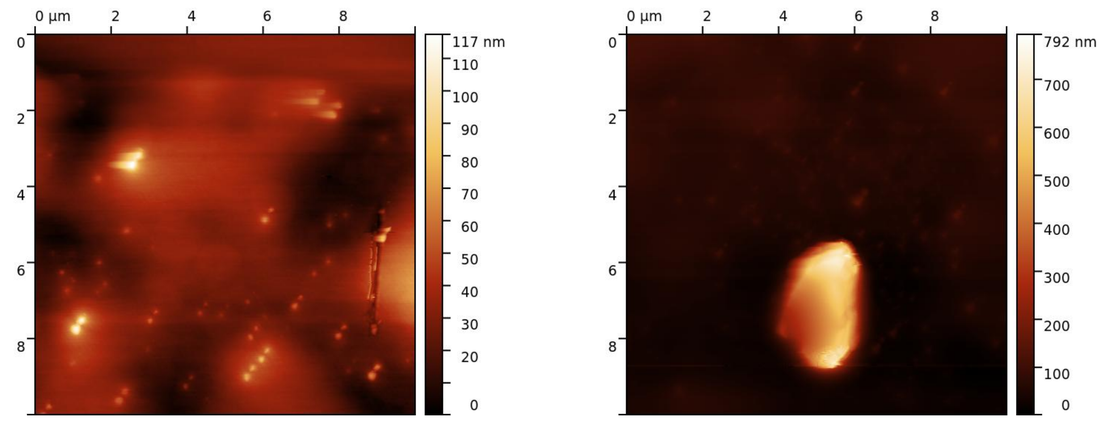
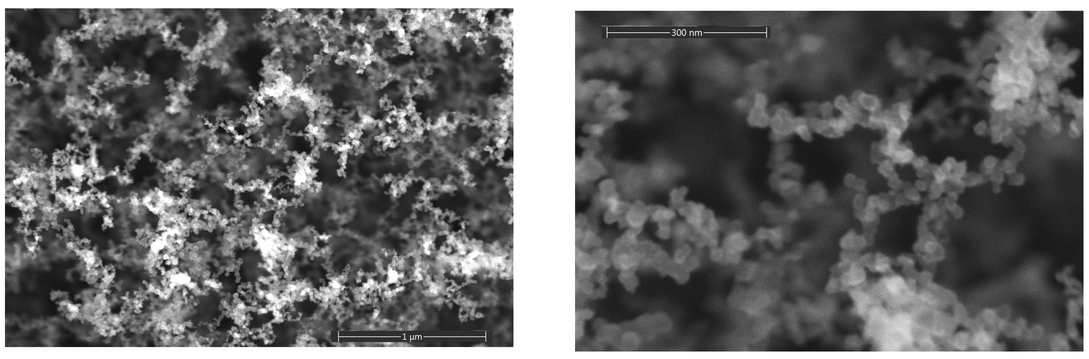
Results & Conclusions

Sample 1 - cigarette



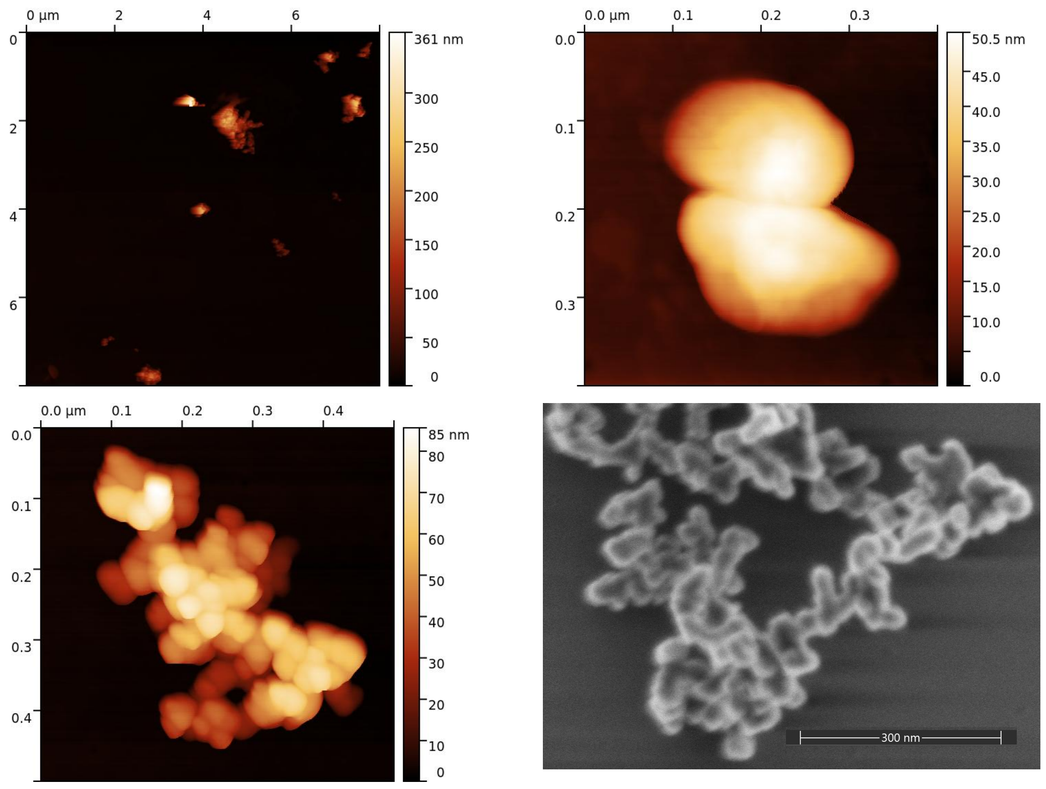
AFM images of first sample. Many small spherical particles with approximate diameter of 300 nm are visible on the left image. One large non-spherical particle on the right image.

Sample 2 - lighter



Electron microscopy images of second sample. Glass substrate was densely covered with layer of soot. AFM image capture was not possible due to attachment of sample material to the AFM tip.

Sample 3 - inverted burner



AFM images and one electron microscopy (bottom right) image of third sample. Top left overview picture shows infrequent distribution of particles on glass substrate. Top right picture shows two connected particles. Bottom pictures demonstare appearance of similar structures captured using AFM and electron microscopy.

Atomic force microscopy measurement was succcessful on samples that were not fully covered with carbonaceous aerosol particles. Comparison of AFM and electron microscopy images of third sample shows that AFM technique can be successfully used for high-quality topography measurements of carbonaceous particles. Second sample was not suitable for AFM measurement, adhesion of particles to the sample was too low, electron microscopy is better technique for this type of samples.