Advanced Electrospray Aerosol Generator with Integrated Soft X-ray Neutralizer

Torsten Tritscher¹, Aaron Avenido², Axel F. Zerrath², Tim Johnson², Jacob H.T. Scheckman², Thomas Krinke¹, Florian Dahlkötter¹ and Oliver F. Bischof¹

¹TSI GmbH, Particle Instruments, Neuköllner Str. 4, 52068, Aachen, Germany
²TSI Inc., 500 Cardigan Road, 55126, Shoreview, MN, USA

Keywords: Nanoparticle, Electrospray, Scanning mobility particle sizer, Soft X-ray neutralizer

An electrospray is a suitable technique for the generation of aerosols from suspended particles and solutions of dissolved solutes. Electrospray (ES or nano-ES) offers significant advantages as a particle source for aerosol measurements with e.g. Scanning Mobility Particle Sizers (SMPS) due to its ability to produce stable, uniform and small (~150 nm) initial liquid droplets. The method is commonly used to disperse particles as small as 2 nm up to 150 nm or even larger. These particles can then be analyzed in applications including basic aerosol research, protein sizing, manufactured nanoparticle sizing and others.

The droplets formed by electrospray generation are highly charged and decrease in size as they dry. The surface charge on the droplet increases and the repulsive force can cause them to fragment. The droplets can be neutralized using a radioactive source like Po-210 (Kaufman et al., 1993) to avoid droplet disintegration and particle losses.

Low energy soft X-ray neutralizers are frequently employed as an alternative to radioactive sources (Shimada et al., 2002; Lee et al. 2005). Both types of neutralizers are able to bring particles to a stable bipolar charge distribution. This has recently been characterized for use in SMPS measurements (Knobel, et al., 2013).

In this paper we present a new Electrospray Aerosol Generator (EAG, TSI model 3482) with an integrated soft X-ray neutralizer, see Figure 1.

The advanced EAG presented here has been designed to improve usability. A key element in any electrospray is the status feedback of the Taylor cone generated by balancing flows and voltages. A digital camera is used to produce the image of the electrospray cone at the tip of the capillary and the live video image is shown on the instrument’s touch panel display.

Additionally, a particularly short capillary is used, so the surface area for particle adhesion is minimized and occurrences of capillary clogging are greatly reduced. The new capillary mount is also designed for easy replacement.

Standard connectors are used for connection to an external pump, such as a high pressure piston pump, e.g. HPLC pump or an easy-to-use syringe pump. Use of an external pump also allows for an easy connection to an autosampler for automated sample analysis.

The size of the generated droplets was characterized during verification of this new device. We evaluated the stability of the particle output and the charge state of the generated droplets after neutralization. The EAG was then used to aerosolize PSL, colloidal silica (shown in Figure 2), and proteins of known molecular mass for further size distribution analysis with SMPS.


