Effects of downstream RF plasma cleaning on the surface of polystyrene and polyetheretherketone

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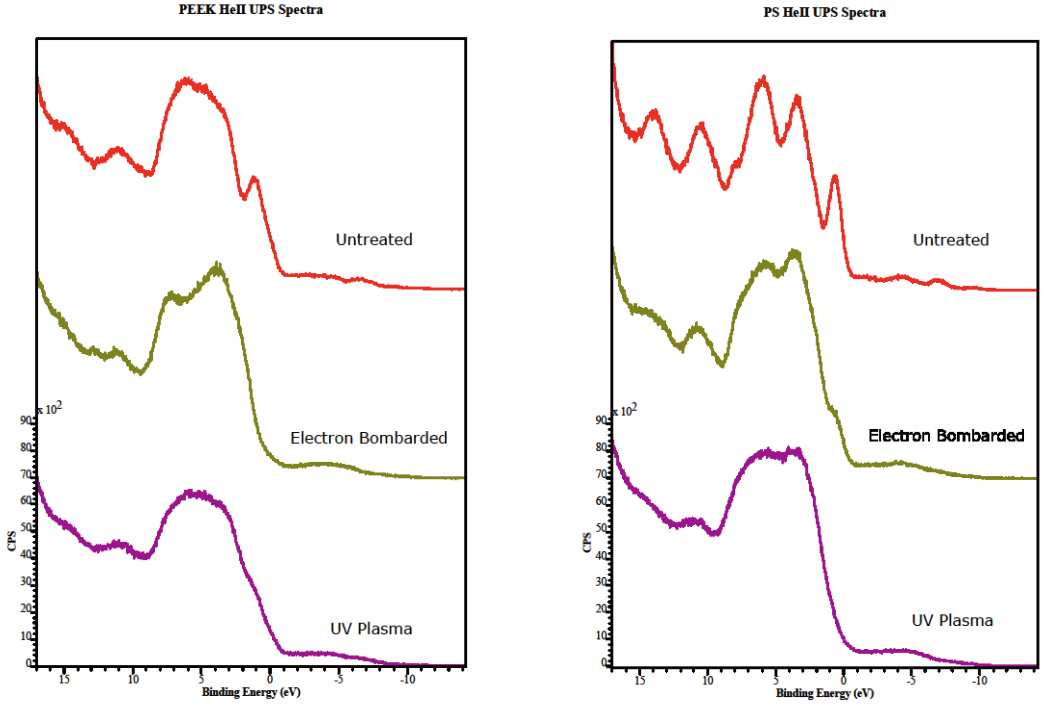
Downstream RF plasma cleaning is largely considered a non-destructive decontamination/cleaning method for the removal of contaminating hydrocarbons from vacuum based systems and instrumentation and from samples [1-3]. Downstream plasma cleaning is different to traditional ion based cleaning methods in that the items to be decontaminated/cleaned are not directly bombarded by relatively high energy ions (keV energy range) but are indirectly flooded by low energy (10s of eV) ions and neutrals [4]. The decontamination of hydrocarbons from the surfaces of interest is largely due to the chemisorption of the plasma gas ions and neutrals which then produce volatile, gaseous compounds which are then pumped out of the system [5]. Even though the downstream RF plasma process is used to clean hydrocarbon contaminates from surfaces, it is also considered to not damage carbon based samples and surfaces such as graphite based compounds (e.g. carbon nanotubes) [6] and polymers [7].

With the need for samples to be characterised by a variety of techniques to understand their physical and chemical makeup, it is important to understand how any sample preparation and cleaning may affect the ability of selected characterisation techniques to produce reliable data and to understand how to negate the effects of these introduced artefacts, if possible. We will endeavour to discover if downstream RF plasma processes will affect the ability of surface sensitive characterisation methods to produce reliable data.

We exposed polystyrene (PS) and polyetheretherketone (PEEK) to a downstream RF plasma produced by an Evactron 25 Decontaminator for 10 minutes at a power of 14 Watts utilising air as a gas source, and with a base pressure of 400 mTorr, and as a control PS and PEEK samples were exposed to a 5 kV electron beam in a JCM5000 Neoscope scanning electron microscope (SEM). The sample surface chemical composition was measured by X-ray photoelectron spectroscopy (XPS) utilising an Al $K\alpha$ monochromatic source (1486.6 eV), and by Ultraviolet photoelectron spectroscopy (UPS) utilising the HeII (40.8 eV) part of the source spectrum.

Significant changes were measured by UPS (see figures below) indicating that the surface chemical composition of the samples is being modified by the downstream plasma. Similar, but more subtle changes were detected by XPS indicating that a graphitic like composition is being produced at or near the sample surface. The ramifications of this can be quite significant, in that the order of characterisation and sample prep/cleaning needs to be considered carefully to reduce the possibility of inaccurate measurements and analysis due to unwanted modification of the sample.



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