High power impulse magnetron sputtering (HIPIMS) and traditional pulsed sputtering (DCMSP) Ag-surfaces leading to *E. coli* inactivation

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This study addresses the high power impulse magnetron sputtering (HIPIMS) deposition of Ag-nanoparticle films on polyester and the comparison with films deposited by direct current pulsed magnetron sputtering (DCMSP).

The first evidence is presented for the *E. coli* bacterial inactivation by HIPIMS sputtered polyester compared to Ag-polyester sputtered by DCMSP. HIPIMS layers were significantly thinner than the DCMSP sputtered layers needing a much lower Ag-loading to inactivate *E. coli* within the same time scale. The Ag-nanoparticle films sputtered by DCMSP at 300 mA for 160s was observed to inactivate completely *E. coli* within 2 hours having a content of 0.205% Ag wt%/polyester wt%. HIPIMS-sputtered at 5 Amp for 75s led to complete *E. coli* bacterial inactivation also within 2 hours having a content Ag 0.031% Ag wt%/polyester wt%. The atomic rate of deposition with DCMSP is 6.2x10\(^{15}\) atoms Ag/cm\(^2\)s while with HPIMS this rate was 2.7x10\(^{15}\) atoms Ag/cm\(^2\)s. The degree of ionization of Ag\(^+\)/Ag\(^{2+}\) and Ar\(^+\)/Ar\(^{2+}\) was proportional to the target current applied during HIPIMS-sputtering as determined by mass spectroscopy. These experiments reveal significant differences at the higher end of the currents applied during HIPIMS sputtering as illustrated by the ion-flux composition. X-ray photoelectron spectroscopy (XPS) was used to determine the surface atomic concentration of O, Ag, and C on the Ag-polyester. These surface atomic concentrations were followed during the *E. coli* inactivation time providing the evidence for the *E. coli* oxidation on the Ag-polyester. X-ray diffraction shows Ag-metallic character for DCMSP sputtered samples for longer times compared to the Ag-clusters sputtered by HIPIMS leading to Ag-clusters aggregates. Ag-nanoparticle films on polyester sputtered by HIPIMS contain less Ag and are thinner compared to Ag-nanoparticle films sputtered by DCMSP.
The mass spectroscopy analysis of the ions in the chamber was carried out by way of a Hiden mass spectrometer connected with the DC-magnetron gas chamber. The $\text{Ar}^+$, $\text{Ar}^{2+}$ and $\text{Ag}^+$ and $\text{Ag}^{2+}$ ions were determined. With increasing current the $\text{Ar}^+$ decreases and the $\text{Ag}^+$ gas phase increases. At higher discharge currents $\text{Ag}^+$-ions exceeded the amount of $\text{Ar}^+$-ions. The most interesting result is that HIPIMS discharges at 10 A peak current produced high quantities of $\text{Ag}^+$-ions along a small amount of $\text{Ag}^{2+}$-ions.

Transmission electron microscopy of Ag-polyester fibers sputtered by HIPIMS at 5 Amps for 150s. E in stands for epoxide used during the preparation

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**Paper Reference:**

**Hiden Product:**
EQP Mass & Energy Analyser for Plasma Diagnostics

[Follow the link to the product catalogue on our website for further information](http://www.hidenanalytical.com/en/products/for-thin-films-plasma-surface-engineering/eqp)