Application of Linear Ion Source Technology for TCO Coating

J. Müller
joachim.mueller@
aei.com

Th. Linz
Advanced Energy
Industries GmbH

M. Frati
D. Shaw
Advanced Energy
Industries Inc.

Closed drift linear ion sources (LIS) have numerous applications in industrial vacuum PVD and CVD processes. The closed drift ion source technology relies on a simple and robust design principle without any grids or heated filaments. This makes it ideally suited to run in harsh industrial environments and allows the use of highly reactive process gases such as oxygen. In addition to ion beam assisted deposition, typical applications are substrate pretreatment (e.g. cleaning, etching or surface activation), or post-deposition modification of films by ion bombardment.

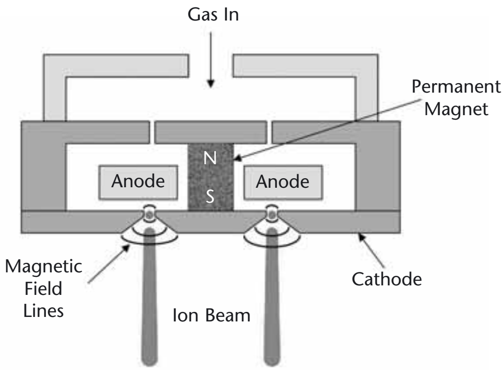


Figure 1
Cross section view of a closed drift ion source (LIS)

Principle of operation

The power supply delivers high voltage of up to 3 kV to the anode *(Fig. 1)*. The cathodes and the edges of the race-track shaped emission slit are made of soft iron, while the

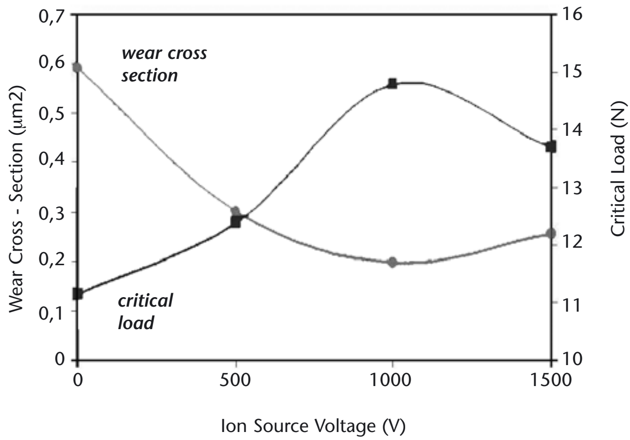


Figure 2
Improvement of mechanical properties of sputtered ZnO-films on LIS-pretreated float glass substrates as a function of the accelerating voltage

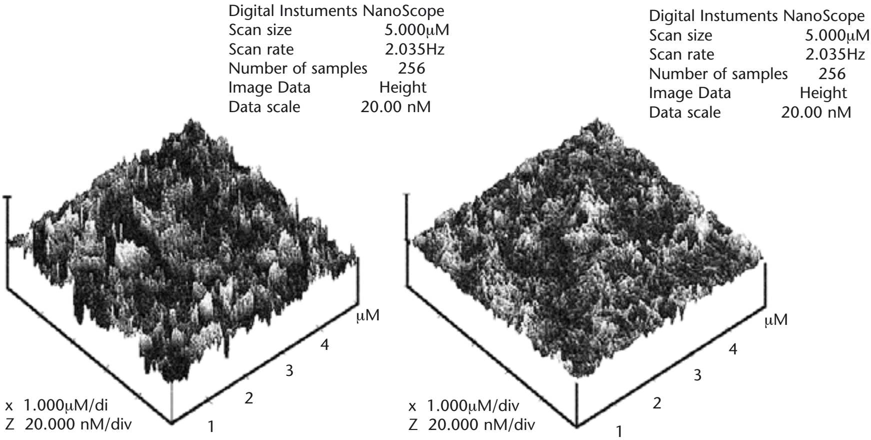
anode consists of non-magnetic stainless steel. The LIS utilizes a permanent magnet to create a magnetic field between the magnetic poles of the cathodes. Electrons confined in this field collide with the supplied source gas, ionize it, and created ions are accelerated away from the source. Depending on the operating conditions the resulting ion beam will either be highly collimated (high energy, low current) or diffuse (lower voltage, high current). For more details on the physics see [1].

Application Examples

LIS treatment can be used to adjust and modify the properties of sputtered TCO films. As one example, *Fig. 2* shows how the hardness and scratch resistance of a sputtered ZnO film can be improved, when the film is deposited on LIS pre-treated float glass. The film properties are best at an accelerating voltage of 1.000 V, while for even higher

Figure 3
AFM scan of sputtered ITO films before (left, δ_{rms} ITO = 3.7 nm) and after (right, δ_{rms} ITO = 2.0 nm) LIS treatment (ion beam: Ar:O_2 = 1:1, 3 kV)

voltages film properties start to worsen again (over treatment). A second application shown in *Fig. 3* is the post deposition treatment of sputtered ITO films, which leads to an extremely smooth ITO surface, e.g. for the use in flat panel display manufacturing.



Literature

[1] V. V. Zhurin, H. R. Kaufman, R. S. Robinsons, Plasma Sources Sci. Technol. 8 (1999) R1-R20.

[2] P. J. Kelly, G. T. West, in: J. Puetz, A. Kurz, M. A. Aegerter (eds.); Proc. ICCG-5, Saarbrücken, Germany, July 4-8 (2004), pp. 153-158.