Active Anodes
Magnetic Guidance of Plasma Electrons

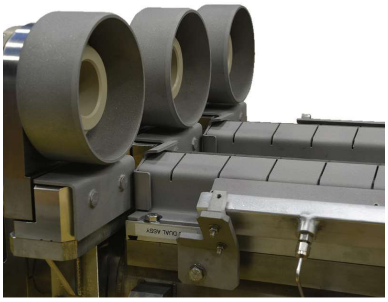
Gencoa's active anode technology is an accessory for sputtering from rotatable magnetrons. Active anodes provide a range of benefits such as:

• Lower substrate temperatures
• Higher rates for temperature sensitive substrates
• Reduced target voltage fluctuations with substrate movement
• Less process drift
• Control of energy at the growing film and lower film stress
• Harder carbon VDLC layers

Electron guidance into an active anode

An active anode combines magnetic and electrical channeling of electrons that have lost enough energy to escape the rotatable magnetron magnetic trap. Efficient collection of electrons is important, as a magnetron plasma is essentially an electric circuit which requires a stable electrode to collect the electron current, in order to preserve energy and operate efficiently. Planar magnetrons are able to collect the electrons as the dark space shields surrounding the cathodes intersect with the magnetic field lines, which consumes the electrons as they progress away from the target.

Rotatable magnetrons don't typically use a dark space shield as its problematic to incorporate them reliably. Additionally, avoiding anode structures too



Active anodes behind rotatable targets

close to a rotatable target is essential in order to prevent coating buildup and the possible generation of particles and dust on the substrate.

The use of active magnetic guidance of electrons away from the target surface to the rear of the cathode structure prevents electrons 'finding' the substrate and chamber walls in an uncontrolled way.

If the active anode is connected to the positive output of a DC magnetron power supply, 100% of the electrons will be collected. In an AC type circuit the active anodes act as a partial electron collector with the additional benefit of providing cycling positive and negative bombardment of the growing film.

Substrate Temperature Reduction and Rate Increase

When coating temperature-sensitive substrates such as thin plastic web material, the rates of deposition will be limited by the heat input from the coating process. The majority of heat is generated by the heat of condensation of the atoms that are deposited. However another source of heat that can be controlled is related to the plasma electrons. The bulk plasma can be controlled by the magnetic field confinement over the target and its ability to prevent plasma contact with the substrate surface. This, combined with channelling of all the electrons away from the substrate, provides the best possible arrangement to limit the additional heating of the substrate. Once the heat input is lowered, more power can be applied to the target which increases the maximum deposition rate.

Reduced Target Voltage Fluctuation

As large insulating substrates such as glass panels pass by a confined sputtering plasma, there is an effect on the plasma impedance as a result of the disturbance that this large electrically floating mass imposes on the plasma as it moves past. The disturbance of the plasma changes the voltage of the sputter target. These small voltage changes can be problematic in terms of the control of rates and hence uniformity.

For a DC or AC type rotatable magnetron plasma, the use of an active anode reduces or eliminates the voltage fluctuations, delivering improved rate and uniformity control.

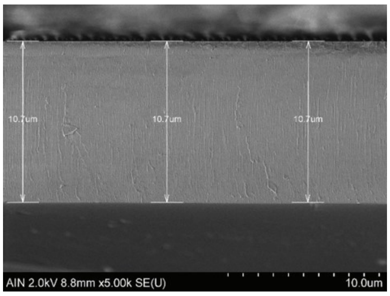
Lower process drift

In addition to reducing process disturbance, the use of an active anode can reduce process drift during the deposition of dielectric layers or semiconductors. When depositing an insulating coating, the substrate becomes coated, and the chamber walls and all other chamber hardware is gradually covered with a thick layer of insulating or poorly conducting material. If the electrons rely upon the chamber ground as the path to earth, then this is gradually decreased as the coating forms on the surface of all the parts.

Control of energy and stress of the growing film

The active anode can be used to good effect to control the energy imparted to the growing film. This is a function of the electron extraction and the switching of power between the two cathodes. The presence of an active anode imposes pulses of positive and negative bombardment during each phase of the power applied to the cathode(s). This energy can be controlled from a few electron volts to tens of eV by the pulsing characteristics of the magnetron power supply. This extra energy has the ability to improve the film quality and hardness by densifying the coating structure. The ion assistance during this deposition phase can avoid the need for additional ion sources when depositing high quality optical coatings.

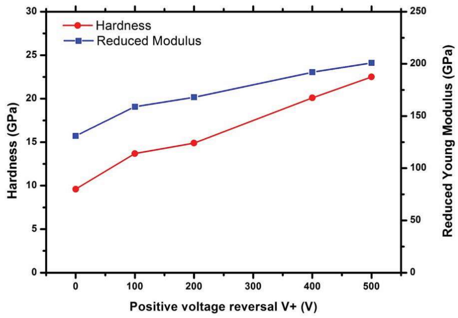
Internal coating stress is a function of the bombardment during film growth and whether the bombardment is positive or negative in nature. As the active anodes impose both positive and negative assistance, the films are highly dense with low levels of internal stress. Oxide layers of tens of microns in thickness can be created without substrate adhesion problems. On insulating substrates there is lower charge build up as the cycles of positive and negative pulses have an overall neutral charge. This avoids arcs on the film and damage to delicate structures, as well as reducing the ‘picture frame’ effect on coated glass.



AC power with active anode produces highly dense structure

High hardness carbon films V±EE DLC

Deposition of hard carbon layers onto insulating substrates such as glass is hampered by the inability to apply a bias to the glass. Hard carbon layers can be achieved by applying a positive pulse reversal on the magnetron target. The effect is to accelerate energetic species away from the target that can be used to harden the carbon film. In order to utilise the positive bombardment effectively, the electrons need to be diverted away from the substrate. The active anode performs the diversion of the electrons and results in a doubling of the hardness. The process is named VDLC and produces highly transparent and scratch resistant carbon layer on glass.

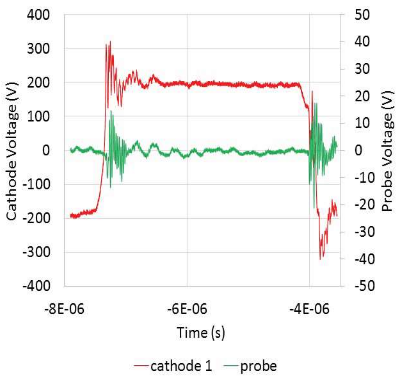


A higher positive pulse leads to greater bombardment and a harder carbon layer

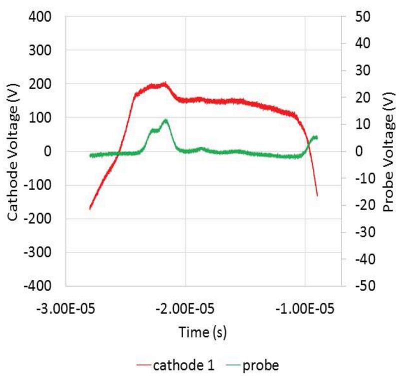
Further information

For more information, contact **sales@gencoa.com** or visit **www.gencoa.com**

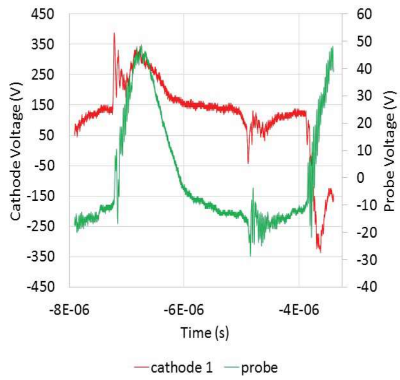
By switching electrons between targets extra ionisation is created. The active anodes create positive and negative energy bursts on the substrate, which is ideal for glass or plastic substrates without external bias



Standard square wave switching with active anode



Standard AC power with active anode



Square wave switching with 1μsec delay and active anode

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