

EXHIBIT D.04
U.S. Patent No. 6,853,142

References cited herein:

- U.S. Pat. No. 6,853,142 (“’142 Patent”)
- D.V. Mozgrin, *et al*, High-Current Low-Pressure Quasi-Stationary Discharge in a Magnetic Field: Experimental Research, Plasma Physics Reports, Vol. 21, No. 5, 1995 (“Mozgrin”)
- U.S. Pat. No. 6,190,512 (“Lantsman”)
- A. A. Kudryavtsev, *et al*, Ionization relaxation in a plasma produced by a pulsed inert-gas discharge, Sov. Phys. Tech. Phys. 28(1), January 1983 (“Kudryavtsev”)
- Dennis M. Manos & Daniel L. Flamm, Plasma Etching: An Introduction, Academic Press 1989 (“Manos”)
- Milton Ohring, The Material Science of Thin Films, Academic Press, 1992 (“Ohring”)
- Donald L. Smith, Thin-Film Deposition: Principles & Practice, McGraw Hill, 1995 (“Smith”)

‘142 Claims 2 and 11	Mozgrin in view of Lantsman and Kudryavtsev
<p>[1pre.] An apparatus for generating a strongly-ionized plasma in a chamber, the apparatus comprising:</p>	<p>The combination of Mozgrin and Lantsman discloses an apparatus for generating a strongly-ionized plasma in a chamber.</p> <p>‘142 Patent at claim 18 (“wherein the peak plasma density of the strongly-ionized plasma is greater than about 10^{12} cm^{-3}”)</p> <p>Mozgrin at Fig 1</p> <p>Mozgrin at 400, right col, ¶ 4 (“To study the high-current forms of the discharge, we used two types of devices: a planar magnetron and a system with specifically shaped hollow electrodes.”)</p> <p>Mozgrin at 401, right col, ¶ 2 (“For pre-ionization ... the initial plasma density in the $10^9 - 10^{11} \text{ cm}^{-3}$ range.”)</p> <p>Mozgrin at 409, left col, ¶ 4 (“The implementation of the high-current magnetron discharge (regime 2) in sputtering ... plasma density (exceeding $2 \times 10^{13} \text{ cm}^{-3}$).”)</p> <p>Mozgrin at 409, left col, ¶ 5 (“The high-current diffuse discharge (regime 3) is useful for producing large-volume</p>

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	uniform dense plasmas $n_i \cong 1.5 \times 10^{15} \text{ cm}^{-3} \dots$ ”).
<p>[1a.] an ionization source that generates a weakly-ionized plasma from a feed gas, the weakly-ionized plasma reducing the probability of developing an electrical breakdown condition in the chamber;</p>	<p>The combination of Mozgrin and Lantsman discloses an ionization source that generates a weakly-ionized plasma from a feed gas, the weakly-ionized plasma reducing the probability of developing an electrical breakdown condition in the chamber.</p> <p>‘142 Patent at 5:18-19 (“The weakly-ionized plasma is also referred to as a pre-ionized plasma.”)</p> <p>‘142 Patent at claim 17 (“wherein the peak plasma density of the <i>weakly-ionized plasma is less than about 10^{12} cm^{-3}</i>”)</p> <p>Mozgrin at Figs. 1, 2, 3, 6, 7</p> <p>Mozgrin at 402, right col, ¶2 (“Figure 3 shows typical voltage and current oscillograms.... Part I in the voltage oscillogram represents the voltage of the stationary discharge (pre-ionization stage).”)</p> <p>Mozgrin at 401, right col, ¶2 (“[f]or pre-ionization, we used a stationary magnetron discharge; ... provided the initial plasma density in the $10^9 - 10^{11} \text{ cm}^{-3}$ range.”)</p> <p>Mozgrin at 400, right col, ¶ 3 (“We investigated the discharge regimes in <i>various gas mixtures</i> at $10^{-3} - 10$ torr...”)</p> <p>402, ¶ spanning left and right cols (“We studied the high-current discharge in wide ranges of discharge current...and operating pressure...<i>using various gases (Ar, N₂, SF₆, and H₂)</i> or their mixtures of various composition...”)</p> <p>Mozgrin at 401, left col, ¶ 1 (“The [plasma] discharge had an annular shape and was <i>adjacent to the cathode.</i>”)</p> <p>Mozgrin at 406, right col, ¶3 (“pre-ionization was not necessary; however, in this case, the probability of discharge transferring to arc mode increased.”)</p> <p>Mozgrin at 400, left col, ¶ 3 (“Some experiments on magnetron systems of various geometry showed that</p>

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	<p>discharge regimes <i>which do not transit to arcs</i> can be obtained even at high currents.”)</p> <p><u>Background:</u></p> <p>Manos at 231 (“We shall ... [include] information on unipolar <i>arcs</i>. <i>These are a problem...</i>”)</p> <p>Manos at 237 (“<i>When such an arc occurs</i>, the metal object is melted at the arc spot. The metal is explosively released.... <i>How does one prevent such an arc?</i> There are several methods...”)</p>
<p>[1b.] a power supply that supplies power to the weakly-ionized plasma though an electrical pulse applied across the weakly-ionized plasma, the electrical pulse having a magnitude and a rise-time that is sufficient to increase the density of the weakly-ionized plasma to generate a strongly-ionized plasma; and</p>	<p>The combination of Mozgrin and Lantsman discloses a power supply that supplies power to the weakly-ionized plasma though an electrical pulse applied across the weakly-ionized plasma, the electrical pulse having a magnitude and a rise-time that is sufficient to increase the density of the weakly-ionized plasma to generate a strongly-ionized plasma.</p> <p>‘142 Patent at 1:41-43 (“Magnetron sputtering systems use magnetic fields that are shaped to trap and to concentrate secondary electrons, which are produced by ion bombardment of the target surface.”)</p> <p>‘142 Patent at 1:37-40 (“The plasma is replenished by electron-ion pairs formed by the collision of neutral molecules with secondary electrons generated at the target surface.”)</p> <p>Mozgrin at Figs. 1, 2, 3</p> <p>Mozgrin at 402, right col, ¶ 2 (“Part 1 in the voltage oscillogram represents the voltage of the stationary discharge (pre-ionization stage).”)</p> <p>Mozgrin at 401, right col, ¶ 1 (“Thus, the supply unit was made providing square voltage and current pulses with [rise] times (leading edge) of 5 – 60 μs...”)</p>
<p>[1c.] a gas line that supplies feed gas to the strongly-ionized plasma, the feed gas diffusing the strongly-ionized plasma, thereby</p>	<p>The combination of Mozgrin and Lantsman discloses a gas line that supplies feed gas to the strongly-ionized plasma, the feed gas diffusing the strongly-ionized plasma, thereby allowing additional power from the</p>

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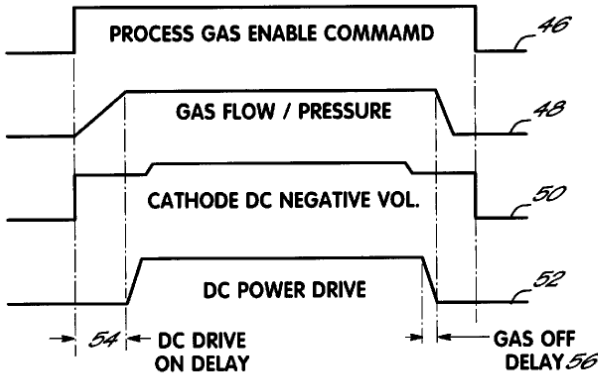
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<p>allowing additional power from the pulsed power supply to be absorbed by the strongly-ionized plasma.</p>	<p>pulsed power supply to be absorbed by the strongly-ionized plasma.</p> <p>It would have been obvious to one of ordinary skill to continue to add the feed gas in Mozgrin during production of the strongly-ionized plasma (i.e., during either of regions 2 or 3). Such addition of the feed gas would have both diffused the strongly-ionized plasma and allowed additional power from Mozgrin's repeating voltage pulses to be absorbed by the strongly-ionized plasma.</p> <p>'142 Patent at 2:21-34 ("FIG. 1 illustrates a cross-sectional view of a known plasma generating apparatus 100.... A feed gas from feed gas source 109, such as an argon gas source, is introduced into the vacuum chamber 104 through a gas inlet 110. The gas flow is controlled by a valve 112.")</p> <p>Mozgrin at Figs. 1 and 3</p> <p>Mozgrin at ¶ spanning pp. 403-404 ("The ... repetition frequency was 10 Hz....").</p> <p>Mozgrin at 401, left col, ¶ 4 ("[A]pplying a square voltage pulse to the discharge gap which was filled up with either neutral or pre-ionized gas.")</p> <p>Lantsman at Fig. 6</p>  <p align="right">FIG. 6</p> <p>Lantsman at 3:9-13 ("[A]t the beginning of processing, this switch is closed and gas is introduced into the</p>

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	<p>chamber. When the plasma process is completed, the gas flow is stopped....”)</p> <p>Lantsman at 4:36-38 (“To end processing, primary supply 10 is disabled, reducing the plasma current and deposition on the wafer. Then, gas flow is terminated....”)</p> <p>Lantsman at 5:39-42 (“Sometime thereafter, gas flow is initiated and the gas flow and pressure (trace 48) begin to ramp upwards toward normal processing levels.”)</p> <p>Lantsman at 5:42-45</p> <p>Lantsman at 2:48-51 (“This secondary power supply ‘pre-ignites’ the plasma so that when the primary power supply is applied, the system smoothly transitions to final plasma development and deposition.”)</p> <p>It would have been obvious to one of ordinary skill to continue to apply the feed gas during Mozgrin’s regions 1 and 2 as taught by Lantsman. Such a continuous introduction of feed gas balances gas withdrawn by the vacuum system (e.g., as shown in the drawings from Ohring and Smith, copied below) so as to maintain a desired pressure.</p> <p>One of ordinary skill would have been motivated to combine Mozgrin and Lantsman. Both Mozgrin and Lantsman are directed to sputtering using plasma. <i>See</i> Mozgrin at 409, left col, ¶ 4 (“The implementation of the high-current magnetron discharge (regime 2) in sputtering or layer-deposition technologies provides an enhancement in the flux of deposited materials and plasma density....”); <i>see also</i> Lantsman at 1:6-8 (“This invention relates to reduction of device damage in plasma processes, including DC (magnetron or non-magnetron) sputtering, and RF sputtering.”). Both references also relate to sputtering systems that use two power supplies, one for pre-ionization and one for deposition. <i>See</i> Lantsman at 4:45-47 (“[T]he secondary [power] supply 32 is used to pre-ignite the plasma, whereas the primary [power] supply 10 is used to generate deposition.”); <i>see</i> Mozgrin at Fig. 2. (<i>showing the “high-voltage supply unit” and the “stationary discharge supply unit”</i>)</p>

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