

# IMPULSE™ 20-20 Pulsed Power Module

High Power Impulse Magnetron Sputtering + Positive Kick™



## FEATURES OF THE 20-20

### ⇒ Plug & Play for Production

- Add-on to your existing DC hardware or install as a new integrated system with matched DC supplies for high-throughput, large-area production
- 7U rack, water-cooled for clean production environments with SCPI-based API for remote command, control and monitoring
- Portable unit, team-liftable by two people, requires no handling equipment for installation or transport
- Support for multiplexing multiple Master/Slave units for higher power, e.g. 40—160kW, large rotary or linear magnetrons

### ⇒ Positive Kick™ Pulse

- Accelerate ions to the substrate that normally recycle to target
- User control of positive pulse amplitude, duration, onset delay to adjust ion fraction, metal/noble ratio, ion energy, deposition rate and energy flux to substrate—ideal for temperature sensitive substrates, e.g. PMMA
- Provides precision ion energy control to the substrate—improving adhesion, controlling film stress, tailoring film morphology and achieving deposition conformality for very thick films >100µm and high-aspect 3D features
- Enables >80% HiPIMS ion fractions on insulating substrates without RF bias—superior to traditional pulsed DC or iPVD using RF bias—improving density, adhesion and alleviating stress in the film at room temperature and lowering cost

### ⇒ Flexible, Ultra-Fast Pulse Topology

- Ultra-fast pulsing <<25µs enables >>1A/cm<sup>2</sup> high current density before onset of microarc “hot spot” instabilities
- Innovative arc management allows <200ns detect and industry-leading <500ns quench time—minimizing arc particle formation and maintaining film quality
- Flexible topology allows user to trade peak current and repetition rate for the sputter target material—2kA peak @ up to 2kHz and 0.2kA peak @ up to 20kHz

### ⇒ Ideal For Reactive Sputtering

- Works well with reactive chemistries (e.g. C-H, N, O) for decorative, functional and corrosion resistant coatings
- Enables noble-free sputtering “metal mode” with 100% N<sub>2</sub>, O<sub>2</sub>

### ⇒ Increased Deposition Rate

- Up to 35% increase in dep. rates have been observed, bringing HiPIMS closer to or exceeding DC sputtering



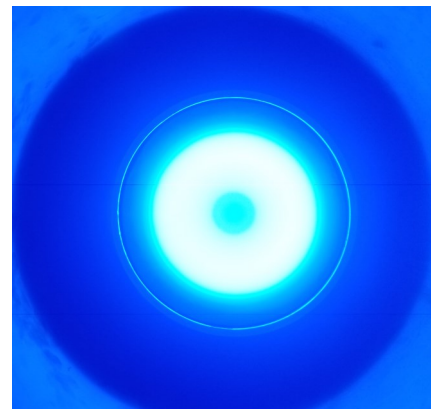
### IMPULSE™ 20-20 Pulsed Power Module

Scaled-up version of the IMPULSE™ 2-2 for production lines and high-volume processing  
Converts a conventional DC sputtering system into a HiPIMS + Positive Kick™ system

## APPLICATIONS

Versatility of the IMPULSE™ 20-20:

- ⇒ Roll-to-Roll, Web, Batch, Wafer
- ⇒ Glass Coatings, Film On Insulator
- ⇒ Dense, Hard Alloy Films
- ⇒ Nanolayer, Nanocomposite Films
- ⇒ High sp<sup>3</sup> ‘at-C’ Diamond
- ⇒ Decorative Coatings
- ⇒ Corrosion-Resistant Coatings
- ⇒ Superior Optical Coatings
- ⇒ Lubricious, Wear Coatings
- ⇒ Stress-Controlled Thick Films



Highly-ionized Carbon Plasma 3" Target

# IMPULSE™ 20-20 PULSED POWER MODULE

High Power Impulse Magnetron Sputtering + Positive Kick™



## VERSATILE FOR ALL MATERIALS

The IMPULSE™ 20-20 is a versatile machine that works well with both easy and difficult to sputter materials in ultra-short and long pulse mode. The ultra-fast topology switches between sequential and parallel mode to achieve the optimal operating environment at both low and high pulse currents. Combined with the Positive Kick™ material deposition rate, ion fraction, ion energy, and energy transfer to the growing film can be tailored for your application need. Additional units multiplex to drive larger cathodes at higher power.

## ULTRA-FAST, POSITIVE KICK™

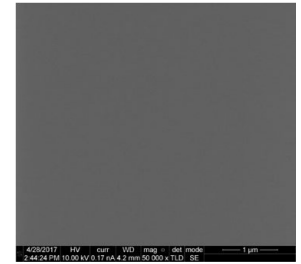
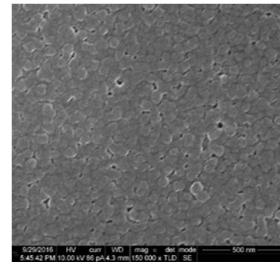
The Positive Kick™ works by quickly reversing the potential across the magnetic field to accelerate ions away from the target. On short time scales, deposition rate increases by redirecting ions that normally 'recycle' back to the target. On long time scales, plasma potential increases driving a substrate sheath and improving deposition conformality. Combined with dense plasma from ultra-fast current pulses (>100A/μs) results in enhanced energetic ion transport to the substrate for ultimate control in film properties.

## BIAS & SYNCHRONIZATION

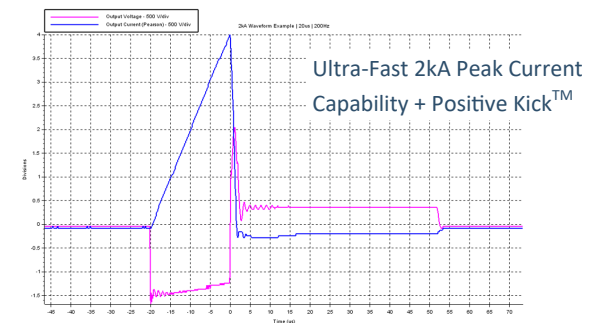
IMPULSE™ 20-20 can be synchronized with other modules for synchronous/asynchronous deposition, co-sputtering and pulsed substrate bias timing capability. Introduced with the IMPULSE™ 2-2 R&D system, process engineers can *selectively choose* which ions will implant in the film densification phase. This allows users to tailor the effective substrate bias energy for metal or dielectric ion implantation while minimizing carrier gas ion effects.

## SPECIFICATIONS

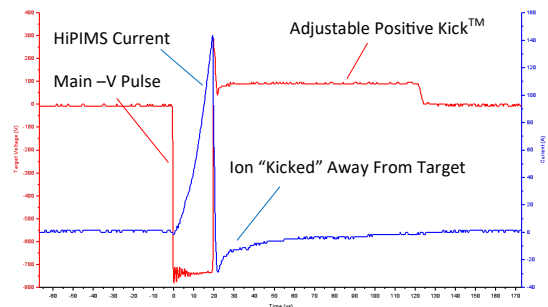
<b>Input Power Specifications</b>	1 Phase, 100-240 VAC, 50/60 Hz, 3 A
<b>Input Charging Supplies</b>	-1250 VDC max, +250 VDC max, 20A nominal
<b>Pulse Output Power</b>	~20 kW time-average, peak power 2.5 MW
<b>Output Peak Voltage</b>	-1000 V nominal, -1250 V max
<b>Output Peak Current</b>	2 kA @ 2kHz, 200A @ 20 kHz
<b>Arc Detect/Suppression</b>	< 200 ns detect, <500 ns suppress
<b>Current, di/dt Threshold</b>	User adjustable to 2kA w/microarc di/dt setpoint
<b>Power Limit Mode</b>	User selectable up to 20kW
<b>Pulse Frequency</b>	1 Hz to 20kHz nominal range
<b>Physical Specifications</b>	7U, 67 lbs, 19" wide, 12.25" height, ~24" depth



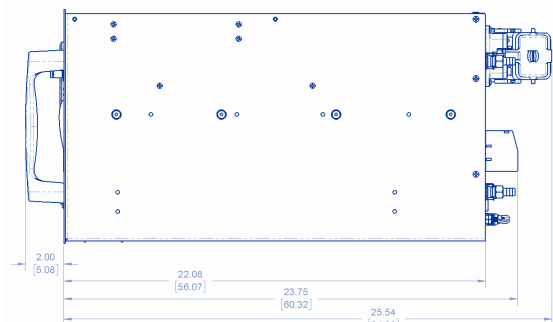
Carbon deposition comparison of DC sputtering (left), with the ultra-smooth, tough, non-porous, hydrogen-free at-C film with >70% sp<sup>3</sup> provided by IMPULSE™ (right)



+200V, 50μs Positive Kick™ after high di/dt triangular pulse  
2000A peak, 20μs on 1m cylindrical Cu cathode @ -750V, 200Hz



+100V, 100μs Positive Kick™ after 150A peak 20μs HiPIMS pulse  
on 3" KJLC Torus® sputter gun with Cu target



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