

# Industrial Diamond Synthesis

Vacuum Pump Solutions for Lab-Grown Diamond Production

## Application Note



## DIAMONDS & HOW THEY ARE MADE

Synthetic diamonds are widely used across various sectors, harnessing their exceptional hardness for cutting and grinding tools in manufacturing and construction. Their optical transparency makes them valuable in precision lenses and laser technology. In electronics, synthetic diamonds efficiently conduct heat, keeping devices cool and functioning even in demanding conditions. They also serve in high-precision tasks, such as detailed cutting and polishing, where accuracy is crucial.

The production of synthetic diamonds through the Microwave Plasma Chemical Vapor Deposition (MPCVD) method involves creating optimal vacuum conditions inside a growth chamber. This process begins by placing a diamond seed in the chamber, which is then evacuated of air to prepare for diamond formation. Hydrogen is introduced, followed by microwaves to generate plasma, heating the substrate to extremely high temperatures. Gases like methane provide the carbon source, while others such as ethanol, acetone, or oxygen can improve the quality of the crystal. The addition of nitrogen can even help accelerate growth.

Over a period of one to four weeks, the diamond grows layer by layer. Vacuum pumps are key in maintaining the precise vacuum needed for this process, ensuring stable and controlled conditions for high-quality diamond synthesis.

## ROLE OF VACUUM PUMPS IN DIAMOND PRODUCTION

Oil-sealed and two-stage rotary vane pumps are commonly employed in the MPCVD process due to their suitability for long-term operation at the fine vacuum levels required for this method. These pumps are specifically designed to handle continuous operation, which is a necessity given the extended periods over which the CVD process runs.

Challenges such as poor lubrication, overheating, and high oil loss can occur when operating under the rough pressure conditions of the CVD process. These pumps are engineered to withstand such rigorous conditions, ensuring that the vacuum pump's performance remains consistent over time. Their robust construction and operational resilience mean that they can endure the harsh chemical environment and high temperatures found within the growth chamber, thus safeguarding the integrity of the diamond production process.



## SOLUTIONS FROM WELCH

Welch is a key provider of vacuum pumps ideally suited for the intricate process of synthetic diamond manufacturing. The company's product line, which includes the CRVpro and Duoseal Series, offers a range of pumps that meet the demanding requirements of this application.



- **Ultimate Vacuum:** The ultimate vacuum these pumps can achieve ranges from  $3 \times 10^{-2}$  to  $2 \times 10^{-4}$



- **Flow Rates:** Flow rates for Welch vacuum pumps vary from 41 l/min to 1486 l/min.



- **Oil Capacity:** The CRVpro series, specifically, boasts an increased oil capacity for enhanced dilution of pollutants and a longer lifespan. The oil capacity ranges from 450 ml to 2400 ml depending on the specific pump model.



- **Operating Temperature:** Welch offers a line of pumps with lower running temperatures, particularly the Duoseal Bvlet-driven rotary vane pump, which extends the pump's lifespan by slowing the breakdown of oil. The CRVpro series is designed to run 10°C cooler than standard rotary vane pumps due to enhanced airflow.



- **Motor Speed:** The Duoseal pump further benefits from a lower RPM motor than other rotary vane pumps, further increasing its lifespan. The motor speed for the CRVpro pumps is 1440/1720 to 1450/1750 rpm, depending on the model and whether it's operating at 50 or 60 Hz.



- **Internal Surface Protection:** The CRVpro series incorporates internal surface protection to enhance durability and extend service intervals. This includes a PTFE coating on the inside of the oil case and a black oxide coating on the outer surface of the pumping module.

The CRVpro and Duoseal series from Welch additionally have unique features making them competitive with other pumps on the market:

- CRVpro series pumps feature coated internal surfaces which, along with the use of a larger oil chamber to dilute chemical vapors, contribute to their enhanced chemical resistance. For applications requiring even greater durability in the face of harsh chemicals, Chemstar pumps offer a specialized solution.
- The extended lifespan of these pumps is achieved through several design choices. The Duoseal series, for example, operates with a lower RPM motor and benefits from increased oil capacity and protection of internal surfaces. These features collectively work to minimize downtime and maximize the longevity of the pumps.

Welch also offers accessories that complement the use of their vacuum pumps. Oil mist filters are available to ensure the operational environment remains clean and safe. For environments with potential explosive hazards, there are customization options to adapt pumps to be explosion-proof, providing an additional layer of safety.



To learn more about the CRVpro Series, including the CRVpro4 pump, please visit:

[Two-Stage Rotary Vane Pumps CRVpro](#)

For detailed information on the Duoseal Series, head over to:

[Belt Drive Vacuum Pumps DUOSEAL](#)

By exploring these resources, you can gain a better understanding of how these Welch vacuum pumps can serve your synthetic diamond synthesis needs.

