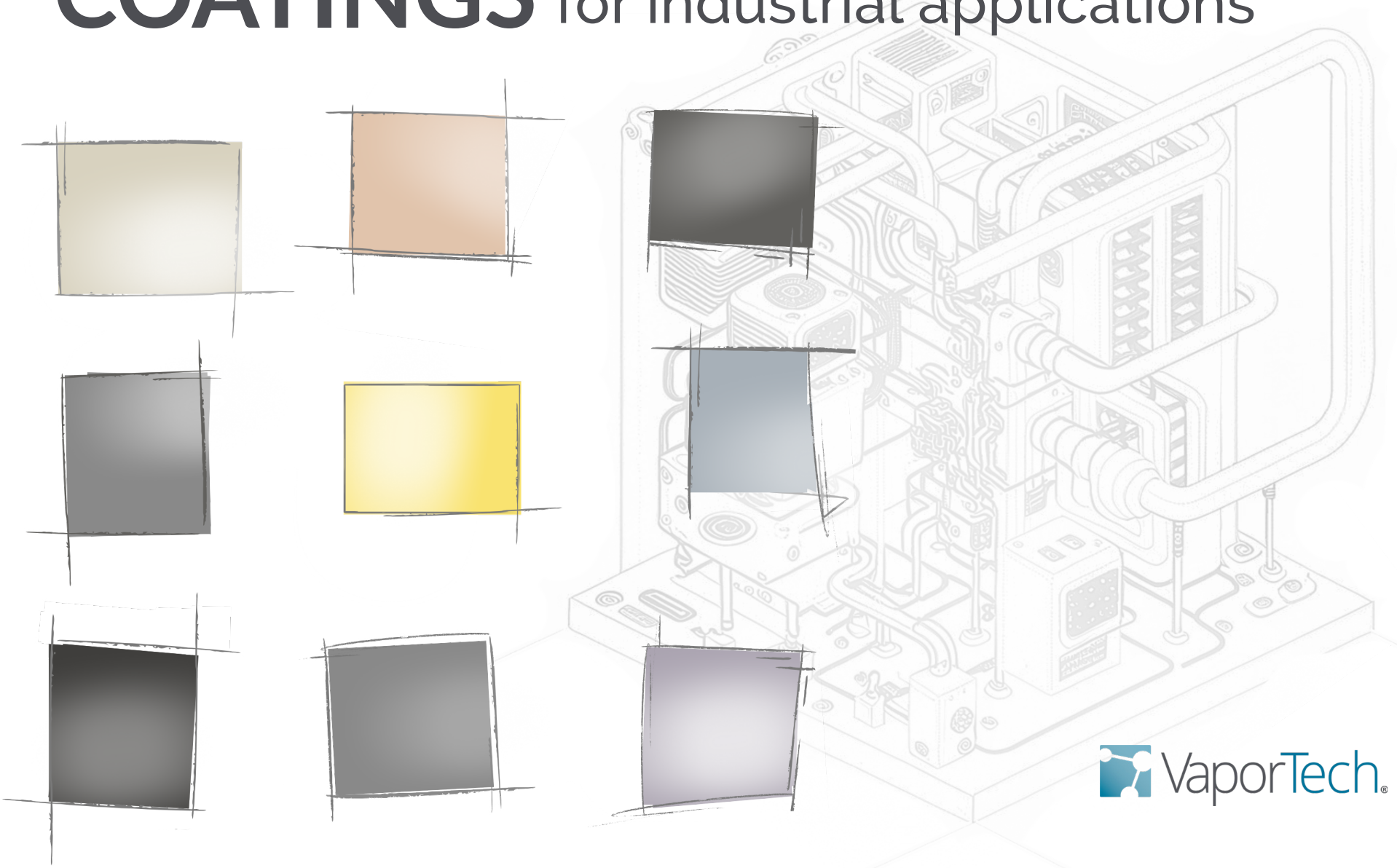
An introduction to

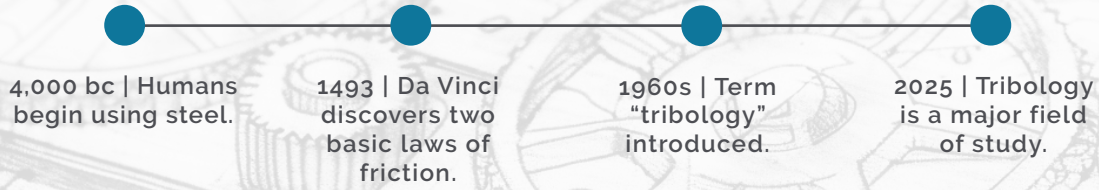
FUNCTIONAL PVD COATINGS for industrial applications



VaporTech®

A HISTORY OF TRIBOLOGY

As documented in his sketchbooks, Leonardo Da Vinci first discovered the two basic laws of friction in 1493.



According to scholars, humans started using steel about 4,000 years ago, forever altering how we live life, work, and fight wars. In ancient Greece and Rome, weapons-makers didn't take long to figure out that a very hard and sharp steel sword that lacks flexibility creates a fragile, breakable blade.

They learned that, in many cases, having different properties on the surface provides the function they were looking for. Since then, humans have figured out how to better create items to be internally flexible but hard and sharp on the outside.

Jump forward to modern times. In the 1960s, a group of UK scholars began studying how to improve the efficiency of industrial manufacturing. The group figured out that the UK could save approximately £500 million a year by reducing friction and wear. Group member Professor Peter Jost, a mechanical engineer, spearheaded the effort to solve the wear and friction problem. Jost coined the term "tribology," meaning the science that would combine physics, chemistry, material engineering, and mechanical engineering to understand and solve these challenges.

Tribology has grown to the point that many companies, universities and research institutes have developed tribology labs. Established and well-known societies worldwide are now studying this field.

SOLVE COMPLEX FRICTION AND WEAR PROBLEMS.

Functional coatings modify the hardness and toughness of the product's surface, improve durability and wear resistance, and reduce friction.

The PVD process creates coatings that help manufacturers optimize their products' performance (and look). As the name suggests, PVD thin-film coatings are much thinner than other finishing technologies, which means the coating doesn't affect tight manufacturing tolerances.

When manufacturers can't solve wear and/or friction problems efficiently, they turn to tribology. Using processes like lower-temperature cathodic arc deposition and magnetron sputtering, these companies get coating properties that match their specific applications. Tribology helps VaporTech® customers change their parts and products' external/surface properties to maximize their desired qualities and minimize potential challenges. For example, the cutting tools used in machining sustain significant impact during operation, which is why manufacturers use extremely thin and friction-resistant PVD-coated metals. This way, the part has the characteristics it needs to function best with a coating that doesn't affect the product tolerance.

TITANIUM NITRIDE (TiN)

TiN gives your product excellent mechanical, corrosive, and thermal properties and biocompatibility.

TiN coating adds hardness and toughness and reduces friction to improve performance and increase your product's lifespan. TiN provides good electrical and thermal conductivity, chemical stability, thermal stability, andoxidation resistance at elevated temperatures.

Manufacturers often use TiN coatings for biomedical, automotive, tools and tooling, and outdoor sports. TiN cubic structure is very compatible with most metallic products, ensuring good coating adhesion on many substrates.

CHROMIUM NITRIDE (CrN)

CrN improves coating performance in high-wear applications.

CrN coating has excellent hardness and toughness, low coefficient of frication, resistance to sliding & impact wear, and resistance to corrosion & oxidation. It offers good release properties.

CrN coating is used for dies and molds, tooling for machining of Cu/Al, engine components, pump parts, and as a replacement for functional plated hard chrome.

ZIRCONIUM NITRIDE (ZrN)

Verstaile ZrN makes an excellent general purpose coating.

ZrN is a nickel to pale-gold brass coating created by adding nitrogen to a zirconium source. It's an excellent general purpose coating with high hardness and toughness, good wear resistance, excellent corrosion resistance, biocompatible.

ZrN is an ideal coating for cutting and punching tools and tooling for machining Al & Ti. It is biocompatible and often used for medical devices and dental instruments.

TITANIUM CARBONITRIDE (TiCN)

TiCN coating extends the life of cutting tools, machine tooling, and other industrial products.

TiCN coating is used for high-wear, high-friction applications because it offers excellent abrasive wear resistance, low friction, high hardness, toughness, and chipping resistance.

Its performance properties mean titanium carbonitride is an excellent choice for cutting and punching tools, dies for plastic injection molding, and high-pressure, low-speed machining.

It's the ideal choice for drilling and reaming applications for machining non-ferrous materials.

TITANIUM ALUMINUM NITRIDE (TiAlN)

TiAlN is a performance coating for demanding machining applications.

TiAlN has high hardness, oxidation resistance, and excellent wear resistance at high temperatures to extend the life of cutting and molding tools. It's ideal for drilling and milling of high-strength steels.

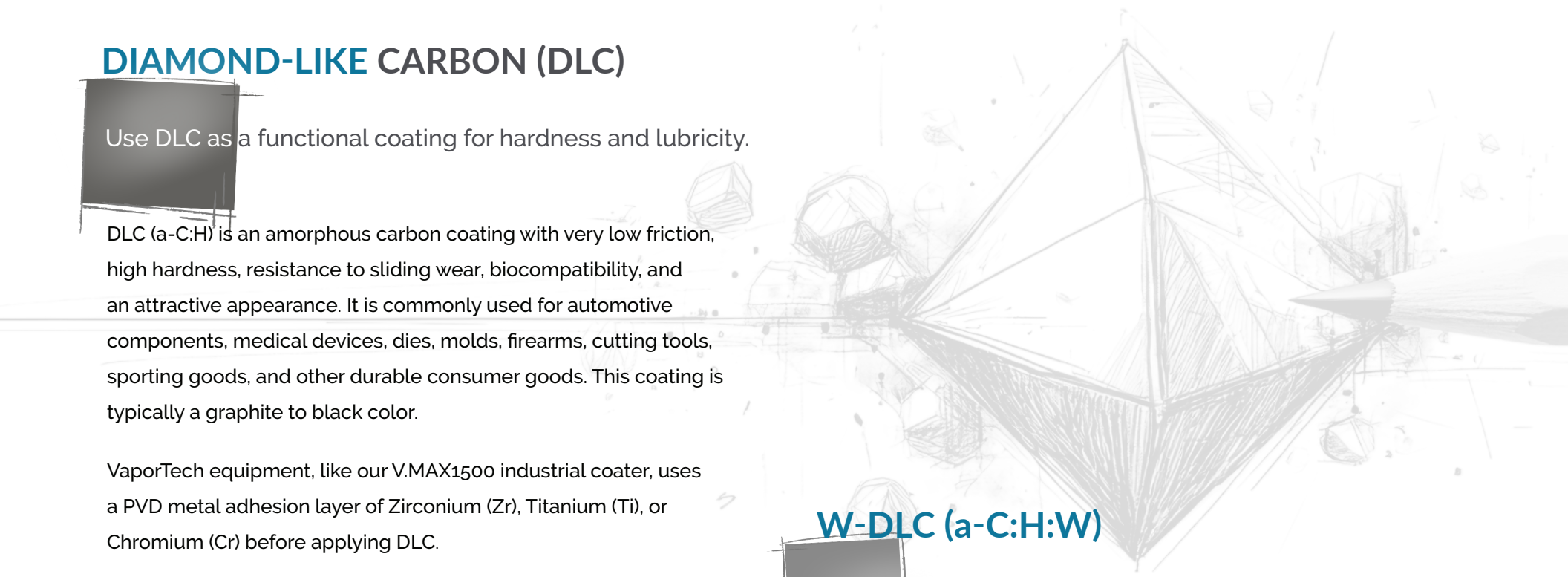
There are benefits to depositing TiAlN via either cathodic arc or magnetron sputtering processes. The VaporTech V.MAX1500™ and VT-1500i™ PVD systems are designed to use both processes, or a combination of the two, depending on specific application needs.

DIAMOND-LIKE CARBON (DLC)

Use DLC as a functional coating for hardness and lubricity.

DLC (a-C:H) is an amorphous carbon coating with very low friction, high hardness, resistance to sliding wear, biocompatibility, and an attractive appearance. It is commonly used for automotive components, medical devices, dies, molds, firearms, cutting tools, sporting goods, and other durable consumer goods. This coating is typically a graphite to black color.

VaporTech equipment, like our V.MAX1500 industrial coater, uses a PVD metal adhesion layer of Zirconium (Zr), Titanium (Ti), or Chromium (Cr) before applying DLC.



W-DLC (a-C:H:W)

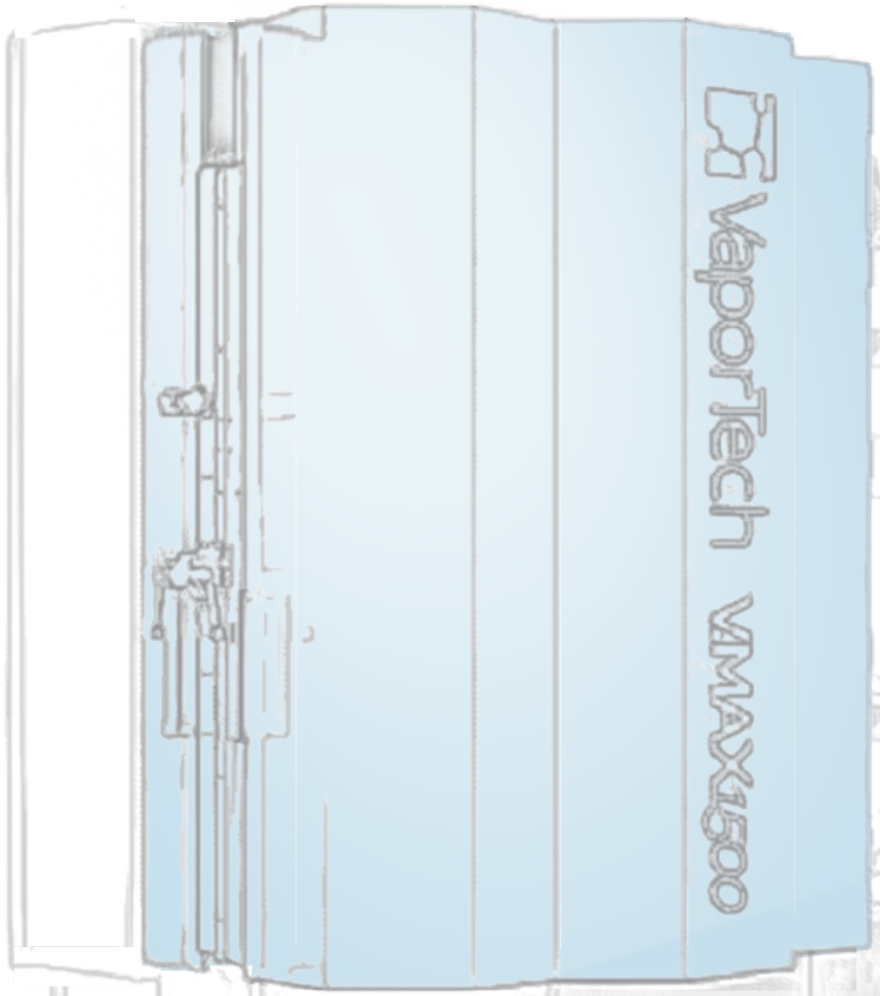
W-DLC adds toughness and lower internal stresses.

W-DLC (a-C:H:W) is a tungsten-doped amorphous carbon coating. With similar wear resistance to the DLC coating described above, W-DLC offers lower internal stresses and more toughness than undoped members of the DLC family.

These a-C:H:W coatings are ideal for applications such as gears, bearings, punches, dies, and molds. They come in shades of gray.

INDUSTRIAL COATING SOLUTIONS

Get the coatings that add value and increase your product's life!



V.MAX1500®

Tribology is key to creating the ideal coating solution for your specific application, and you need to use the right equipment to get the best, most optimal coatings for your products. At VaporTech, our engineers build machines that excel in industrial product coatings and our chemists and physicists develop performance coatings in our dedicated lab.

We've been helping customers apply PVD coatings for more than 30 years as a Masco Corporation (NY:MAS) subsidiary.

Wonder whether our performance coatings & equipment will add function and value to your products? Please contact VaporTech today!

The V.MAX1500 system was designed for coatings that really perform. It offers a combination of up to 6 wall-mounted cathodic arc and/or magnetron sputtering sources for ultimate flexibility and speed. It gives you fast and flexible loading and unloading with 6 or 12 rack positions on a removable turntable. One chamber deposits PVD and DLC coatings and plasma nitriding.

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