ION-PLATING TECHNIQUE AND HARD COATING

(Written by Professor Yuan Zhen Hai, Technical Consultant of Coils Electronic Co., Limited)

Ion-plating technique combines the technique of glow-discharge or arc-discharge of a gas, plasma technique and vacuum evaporation plating technique. The special feature of ion-plating technique is to use the bombardment of ions to interfere the plating process. By making use of the activity of plasmas and the bombardment effect and energy exchange between ions and their substrates, interfaces and the growing films, compounds can be brought into existence under a temperature much lower than that conditioned by traditional thermodynamics, while the density of the films and the adhesion between films/substrates are enhanced as well as the organisation, structure and properties of films are improved.

Ion-plating technique has been extensively applied in the preparation of hard coatings, with cathodic arc deposition and magnetron sputtering as the two mainstream techniques. Other techniques such as thermal arc ion-plating and hole cathodic ion-plating have their special features as well. In recent years, new techniques have been emerging from time to time. For example, unbalance magnetron sputtering with high ionic density, intermediate frequency double target magnetron sputtering for the deposition of media films, superimposed pulse bias technique in low deposition temperature, filtering arc deposition for eliminating macro-particles, various combinations of ion-plating techniques, various combinations of ion sources and ion-plating techniques, etc. have provided more advanced means for the development and production of innovative and advanced hard surface coating.

Ion-plating hard surface coating consists of two categories: the first is a super-hard coating for wear-resisting tools; the other a protective coating for decorative purposes.

Super-hard coating is principally applied on the surface of cutting tools, die equipment and wear-resisting parts as a protective coating. Series of this films include coatings of TiN, ZrN, TiAlN, TiC, TiCN, CrN, diamond-like carbon (DLC), carbon-nitrogen (CNx), etc., all with hardness over Hv2200. In addition, there are series of nano multi-layer films with the super-hardening effect of nano multi-layer structure, such as TiN/AlN, TiN/TiAlN, TiN/W_2N, TiCN/TiN, etc., all with hardness over Hv4000. Recently, there are some solid friction-reducing films emerged, for example, W-C:H, WC-C, MoS_2, DLC, etc. They are deposited on the top layer of some super-hard coatings to become composite multi-layer films, thus providing the function of wear-resisting and friction-reducing. Substrates being deposited include high speed steel, die steel, carbide and high-quality alloy-steel. Products being coated include drill bits, milling cutters, broaches, taps, scissors, moulds, plastic-injected moulds, magnetic powder compacting moulds, plunger dies, forcers, wear-resisting particles for mobiles, medical devices, etc. Coating can enhance the wear-resisting ability of the coated article, lengthen its service life, reduce cost and, at the same time, increase efficiency.

In addition to utilising the coating's wear-resistant and corrosion-resistant functions, decorative protective coating has taken advantage of its special feature, which is the adjustable colour with metallic lustre. Its principal films series include the following: TiN, ZrN, TiN+Au, ZrN+Au, etc. with the colour of gold; CrN and stainless steel with the colour of silver; TiC, TiC+i:C, TiAlNC, DLC, etc. with the colour of black; and TiAlN, TiCN, ZrCN, TiAlCN, Ti-O-C-N, etc. with different colours such as brown, purple, blue and green. Substrates being deposited include stainless steel, yellow copper, zinc alloy, glass, ceramic, etc. Decorative coating products include watch accessories, pen

accessories, cutlery, sanitary ware, kitchen ware, metal furniture, hardware products, lighting ware, building hardware, sports equipment, ceramic and glass products, etc. By now, this technique has been extensively applied in various industries.

I would like to particularly emphasise on the development of ion-films in DLC coating, which may open up a new territory in the future. In addition to the application as stated above, DLC is also a decorative coating for first-class watches (in black and with a high degree of hardness and wear-resistance) and is the friction-reducing and corrosion-resisting coating for a famous brand name razors. DLC is also a protective coating for high-quality film heads for magnetic record. When applied to the diaphragm of loudspeakers, DLC coating can increase acoustic high-frequency response and improve voicing, so it has been adopted by famous hi-fi products in Japan and the USA. The writer is currently managing the industrialisation of this project in Mainland China.

There is a wide range of products using the technique of ion-plating in different industries. This technique is changing rapidly and this industry is developing prosperously. Moreover, ion-plating technique is a technique free from pollution. Therefore, the industrialisation of ion-plating has a lot of peculiarities worth the investors' concern.

Introduction of the Writer:

Yuan Zhen Hai, male; born in December 1939 and a native of Dongguan City, Guangdong Province. Professor Yuan was a postgraduate of the Department of Engineering Physics, Qing Hua University, Mainland China (1967). He is now a Senior Engineer (with the equivalent level as a professor) of the Centre of Material Surface of Guangzhou Nonferrous Metal Research Institute, and concurrently the vice supervisor of National Technique Standardisation Committee for Coating of Metal and Non-metal, committee member of the Consultant Committee of the Chinese Vacuum Society, and director of the standing committee of Guangdong Vacuum Society. Professor Yuan has been engaged in the research and development of material science and engineering for over 30 years, and has mainly devoted in the research and development of ion-plating technique and hard coating in the last decade. He has successfully achieved many breakthroughs in projects on the national, departmental, provincial, and municipal levels, and has researched and developed coatings of TiN, TiC, TiAIN, TiCN, DLC, CNx, etc., and their relevant application which in return earned for him the Science and Technology Improvement Award granted by the departmental, provincial, and municipal authorities seven times. Professor Yuan had also published over twenty academic papers in Mainland China and overseas, and participated in the editing of the significant reference book – "A Design Handbook of Modern Surface Engineering" (現代表面工程設計手冊) (by National Defense Publishing House, 2000). Professor Yuan joined the Group as a Technical Consultant in May 2000. His expertise in ion-plating technique and hard coating has made a significant contribution to the research and development of various types of moulds (such as moulds for ferrite materials, plastics and metals) required in the Group's production cycles and its product quality. He has been playing a very important role in the Group's business development.