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The Hidden Potentiality of Coatings

From university lab to Peruvian industry

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Abstract
Nowadays the growth of technological materials in the form of thin films, layers, or coatings, still remains like one of the topics of greatest vitality, in both the scientific and technological environment. These technological materials already are in various applications of the different products that we use on our daily basis. However, how technology on coatings can help the country's productive sector?. We briefly describe this hidden potential of coatings through this communication to help close the gap between the knowledge production in the academy and the work tools that the Peruvian industry sector needs to improve the quality of its final products.

Keywords: Magnetron Sputtering, Thin films, Layers, Coatings.

La Potencialidad Oculta de los Recubrimientos

Del laboratorio universitario a la industria peruana

Resumen
Hoy en día, el crecimiento de materiales tecnológicos en forma de películas delgadas, capas o recubrimientos, sigue siendo uno de los temas de mayor vitalidad, tanto en el entorno científico como tecnológico. Estos materiales tecnológicos ya se encuentran en diversas aplicaciones de los diferentes productos que utilizamos a diario. Sin embargo, ¿cómo la tecnología en recubrimientos puede ayudar al sector productivo del país? Describimos brevemente este potencial oculto de los recubrimientos a través de esta comunicación para ayudar a cerrar la brecha entre la producción de conocimiento en la academia y las herramientas de trabajo que el sector industrial peruano necesita para mejorar la calidad de sus productos finales.

Palabras clave: Pulverización Catódica, Películas Delgadas, Capas, Recubrimientos.

Peru is a country characterized by having a vast territory with colossal natural resources, as well as enormous human potential, becoming a country with multiple possibilities and opportunities in the region of South America. On one hand, the most successful Peruvian companies and industries, in the last almost fifty years, have ceased to be those dedicated to the production and distribution of commodities whereby the center of the Peruvian economy has been shifting towards knowledge production and distribution activities. On the other hand, one of these centers of knowledge production are the Peruvian universities, which nowadays have various research laboratories where now we can begin to solve the innovation problems that the Peruvian industry has to

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improve its products and make them more competitives.

Currently, in the field of growth of thin films, layers or coatings of new materials, it remains one of the most vital issues, both in the scientific and technological environments [Bra15], [Bra14]. Its applications are very diverse (figure 1), ranging from the production of multilayers for microelectronics, photonics and optoelectronics, passing through the preparation of layers with magnetic or superconducting properties, as well as going through the protection of mechanical parts or coatings for prostheses for medical use [Haw14], this last area of industrial production is a niche to be exploited by the Peruvian sputtering laboratories.

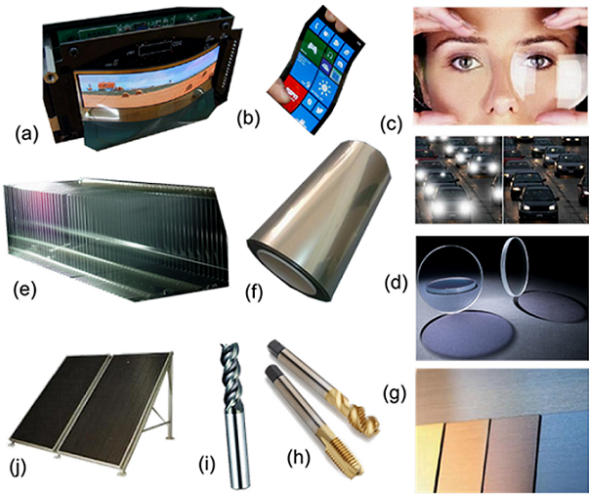

Figure 1: Examples of sputtering coatings: (a) and (b) devices with an Organic Light-Emitting Diode (OLED) display, (c) anti-reflective coatings, (d) laser optics (e) ITO coated glass (Indium Tin Oxide), (f) decorative oxide coatings (h) drill tips coated with TiN, (i) drill bit coated with DLC (Diamond-like-Carbon), (j) solar thermal absorber of Ti-O-N (Adapted from reference [Mar13]).

One of the coating techniques is the magnetron sputtering technique. For almost fifty years the growth of thin layers by magnetron sputtering technique has dominated many industries in the USA and Europe, expanding through Asia and Latin America, while technological evolution, in practice, has brought other physical or chemical techniques for the deposition of such coatings. However, it is then due to the push of digital technology, among semiconductor, optical and magnetic, one of the engines that gave a greater impetus to the development and establishment of the sputtering technique in the last quarter of the 20th century. In addition, many other areas and applications found in this technology the benefits that have made great technological advances possible. Currently we can see everyday objects in which sputtering is part of its manufacturing or functionalization process (figure 1). Such objects can be seen from your home kitchen until to the International Space Station, from the stained glass windows of iconic buildings to cell phones and tablets.

For thin film, layer or coating deposition onto substrate (or material surface) by magnetron sputtering technique, it is necessary to ignite argon plasma inside a vacuum chamber by applying a potential difference between two electrodes, which consists of several hundreds of volts. This plasma consists of pure argon, containing positively charged argon particles (argon ions) and free electrons, then the electric field generated between the two electrodes by the potential difference accelerates the positively charged argon ions towards the negatively charged cathode (the cathode is the solid material that you want to deposit). Argon ions bombard the surface with enough force to dislodge and eject atoms from the blank (surface of solid material). Sputtered material from the solid surface is deposited as a thin film or layer onto the substrate (figure 2). The high kinetic energy of the ejected particles leads to the deposition of thin films or layers with high adhesion. In other words, in a similar way to a billiard game, argon ions displace atoms from the cathode surface by sputtering from the surface of solid material. In this way, the solid material is slowly eroded and the released atoms are transferred through the vacuum chamber to the substrate on the other side, where they are deposited as a thin film, layer or coating, similar to what happens with a bathroom mirror that is covered by water vapor when the shower is running.

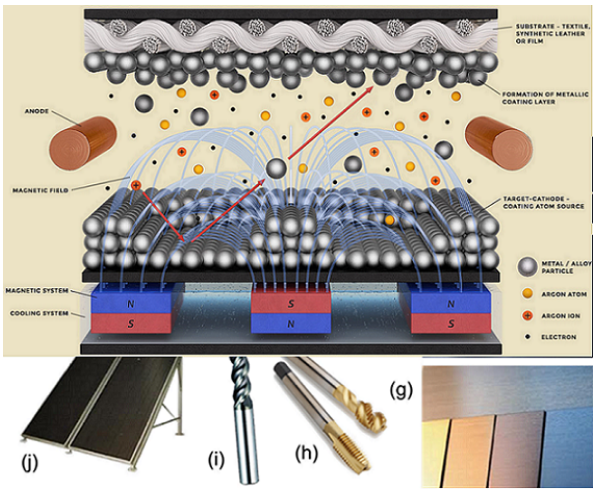

Figure 2: Description of sputtering technique to coat different substrates such as: metal, glass, alloys, fabric, or synthetic leather (Adapted from reference [Far03]).

One of the great advantages of the sputtering processes that can be exploited by the Peruvian industry. This technique allows the deposition of materials such as metals, alloys, ceramics, and even polymers on a wide range of substrates. There is a great need to develop

thin films, layers, and coatings in the Peruvian industry, in order to coat work and cutting tools, gears, windows, and mirrors with high profitability that show superior performance in severe or extreme environments like those existing in our Peruvian reality, such as high or low temperature, oxidation and corrosion, together with high hardness, good wear resistance, greater resistance and greater coating thickness.

Abroad, the sputtering technique has developed until to the point where it has become the process of choice for the deposition of a wide range of thin films, layers, or coatings of industrial importance. The driving force has been increasing demand for high-quality functional thin films, layers, or coatings in many market sectors. However, returning to the Peruvian reality, there are not enough university laboratories with the sputtering technique to grow thin films, layers, or coatings. In spite of that, the few existing labs have mature knowledge of this growth technique on basis of the work done in academic publications, thesis, and training of highly qualified human resources, which allows them, in principle, to be able to advise to Peruvian industry on its need to develop thin films, layers or coatings for its products or tools.

Nevertheless, there is still a gap between the Peruvian industrial sector demand and knowledge supply from the university laboratories, but exceptional circumstances exist. As a result of this fact, technological backwardness and lack of the required quality of the industry's product appear. At this step, it should also be mentioned that the Peruvian state has taken important steps to close this gap in the last years; although, it is still necessary to have more approaches and meeting platforms. However, it must be clear that knowledge production at the university and its effective transfer to the Peruvian industry will increasingly be the predominant factor that will establish the difference in the competitive position of a country's industry.

Finally, we would like to remark that the Peruvian industry should not think that sputtering is a very complex and expensive technology, but rather a technology to invest in, but it is unquestionable that foreign industries have benefited greatly from the vast developments and innovations in all fields related to the sputtering process and the growth of thin layers over the past fifty years. Then, it is evident that the sputtering process is a reliable technology, highly developed and industrially proven, therefore, why not we establish and expand this technology to the Peruvian industry?

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