

Co-deposition process to elaborate a nanocomposite coating with Al₂O₃- NPs with plasmonic effect

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High power impulse magnetron sputtering (HiPIMS) is a known physical vapor deposition (PVD) technique. It's characterized by very short and high amplitude voltage pulse (impulse) applied to the target with low duty cycles and long off-time between pulses.[1] High ionization rate and lower temperature process leads to high quality films with denser structure, smoother morphology, higher hardness and better adhesion properties compared to the conventional sputtering.[2] In recent years, several studies were made using HiPIMS to deposit metal oxides such as, Al₂O₃, TiO₂, CeO₂, Ag₂Cu₂O₃, among others.[3]

Aluminium oxide or alumina (Al₂O₃) is an electrical insulator, which has been used in a wide range of applications (e.g. tooling, electronics, etc.) given its high hardness, high transparency, high abrasive, good thermal and chemical stabilities and corrosion resistance.[3], [4] Noble metals, such Ag or Au can be introduced into the matrix as nanoparticles in order to enhance the electrical, thermal, optical, mechanical properties. One of the main properties of these nanoparticles is their ability to support localized surface plasmon resonances (LSPRs). The excitation of LSPRs by incoming light results in light extinction effects that are related with the nanoparticle's dielectric constant, size, shape and concentration. For this reason, it is essential to be able to produce nanocomposites with good control over the nanoparticle's morphology and its distribution.[5] This work will be divided in 3 sections. First, the optimization of the matrix layer, alumina, applying mid-frequency or HiPIMS. Secondly, Au nanoparticles will be produced using DC and HiPIMS in order to study the optimal process to obtain a good control over the nanoparticle's morphology and distribution on the matrix. Finally, the combination of both processes to create the nanocomposite. In this research, we achieved a good control over the Au nanoparticles morphology and distribution in the silicon wafer/glass substrates using DC mode. The presence of Au nanoparticles led to the appearance of SPR light absorbance peaks positioned in the 555-675 nm range. The samples will be observed by scanning electron microscopy (SEM), transmission electron microscopy (TEM) and atomic force microscopy (AFM) to determine shape and average size of the nanoparticles.

References

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