3D ARCHITECTURETHIN FILMS ON STAINLESS STEEL WIRE FOR MULTIFUNCTIONAL PROPERTIES

The proposal is related to stainless steel alloys wires that are used in numerous applications due to their combination of high corrosion resistance and mechanical properties. However, these stainless steel wires are today sold as commodity productsin a tense economical market competition. This project aims to add value on these wires and to propose new products for end users such as building and construction, medical applications, electronic market. This work aims to develop new materials with a multi-scale approach in terms of design and properties. At nano-and microscopic scales, thin films can be deposited on a wire, and these wires can be combined and assembled at a macroscopic scale to produce new multifunctional objects.

New functionalities may be developed in weaving wires that would be previously coated with thin coatings of different chemical natures. The coating technology allows multi-layers deposition of various compounds such as metal, oxides and nitrides. The functional properties described previously are mostly controlled by the surface. Development of high performance coatings in order to create an architecture surface to produce “materials by design” is the objective of the project.

**Thesis schedule:**

The first year will be devoted to the implementation of the characterization on the two first coatings on the stainless steel wire: TiN to improve the aesthetic aspect by the way of different surface colors versus the thickness and stoichiometry of the thin film and TiO2, to develop enhanced cleanability surfaces due to the photo-induced properties. The coating surface will be characterized by XPS in order to identify carefully the chemical composition (stoichiometry, profile depth…), and in the same time a wettability study will be carried out. Due the special shape of the stainless steel wire, the classical sessile drop analysis cannot be investigated: an original approach by the technique of Wilhelmy using a tensiometer is proposed.

EBSD (Electron Back Scattering Diffraction) will be used in order to study the crystallinity, the grain orientation and an eventual texture of the different coatings.

FIB-SEM microscopy will be very helpful and essential to prepare transversal cross-section thin lamella in order to characterize by TEM the stainless steel/coating interface, the morphological quality of the coating all around the wire and the crystalline quality of the TiO2 and TiN deposits.

The second year will include characterization of the microstructures (SEM, EBSD, FIB-SEM, TEM, ACOM orientation mapping, 3D imaging…), and the related properties. A peculiar attention will be given to the characterization of the different interfaces and adhesion (*in-situ* SEM tensile test).

The third year will be dedicated to the characterization of the functional properties: the physico-chemical knowledge obtained in the 2 first years of the thesis has to optimise the applications. For instance, the durability of the cleanability of TiO2 will be tested with artificial UV light cycling, and the resistance of TiN multilayer will be evaluated by corrosion experiments.

This last year will be strongly focused on the elaboration of the first tissues.

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