ROLE OF SUSPENSION MEDIA FOR ELECTROPHORETIC DEPOSITION: THE CASE OF FUNCTIONAL OXIDES

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Electrophoretic deposition (EPD) is a versatile, electric field-driven technique of forming films (coatings) and bulk objects. The great potential of EPD is related to the possibility of depositing virtually any material, either ceramic, metallic, or polymeric, available in the form of micro- or nanosized powder that can be electrically charged, on various types of substrates, both metallic and non-metallic ones. EPD, being a suspension-based deposition process, requires preparation of a stable, well-dispersed suspension, in which the particles have a sufficient electrophoretic mobility, to ensure the conditions for the formation of uniform and homogeneous deposit. Suspension stability and electrophoretic mobility of particles are dependent on the surface charge and zeta potential of the particles, and on the operation of other stabilization mechanisms, such as steric and electrosteric stabilization, provided by the additives used. These all can be controlled by modification of the composition of a suspension medium. However, the key role of the composition of the suspension media is being frequently underestimated, and the selection of the suspension medium for EPD of a given material is usually based on trial-and-error approach, which requires a significant amount of experimental work until the most adequate conditions are established. That in many cases obstructs the efficiency and reproducibility of EPD process. Regrettably, no universal suspension medium for EPD exists, and for every material to be deposited the most appropriate, optimal medium with selected additives must be designed. However, there is a significant body of knowledge available in literature on the deposition of various materials using different experimental conditions and suspension media. What has been missing is the systematization of the existing data, allowing to identify the similarities and common trends among different systems, and to categorize the deposited materials according to the suspension media typically used with them, in order to indicate the most suitable combinations.

In this work, we attempt to address this problem. Comprehensive, literature-based overview of EPD processes is presented, with the aim of identification of the main effects and mechanisms involved in interactions occurring in the systems based on various suspension media. Properties and characteristics of aqueous suspension media are contrasted with those of non-aqueous ones, such as alcohols, ketones or hydrocarbons, with advantages and disadvantages of the both categories being presented. The main focus of the work is on the selection of suspension media for EPD of functional oxide films. The recent trends in the design of advanced suspension media are also discussed, and some predictions for the future are given. In this regard, the importance of the integration of knowledge from various fields, such as colloid science, surface chemistry, polymer chemistry, and electrochemistry is underlined. This overview, presented from the perspective that relatively little attention has been paid until now, is expected to provide a guideline for the proper selection of the suspension media for EPD, thus facilitating the successful application of the technique