**CONTINUING EDUCATION IN GREEN CHEMICAL PROCESSES FOR AEROSPACE MANUFACTURING:  
THE CASE OF DRAG-OUT**

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**ABSTRACT**

Chemical processes are being utilized in a wide range of industrial manufacturing from nano to macro scale. In aircraft manufacturing, in particular, chemical processes are included in the list of the so-called Special Processes, among other mechanical and metallurgical processes. In this case, chemical processes are being employed mainly for plating, corrosion protection and surface finishing and involve chemical cleaning, deoxidizing, metal plating, anodizing and chemical conversion coatings. These chemical processes, however, are responsible for the majority of the environmental impact of the Special Processes in total, because hazardous substances are being used, process baths are typically large and therefore the effluent loads are high and difficult to manage. Therefore, green chemical processes should be implemented, and the respective Training Curricula should be developed.

One, quite important, aspect in such chemical processes is drag-out, namely the volume of the solution that is being carried out from one process bath to the next one, typically a rinse bath [1]. Drag-out has several impacts ranging from economical and environmental to process control and quality. Drag-out was typically treated as a minor issue in Special Processes. However, green chemical processing dictates increased attention and drag-out minimization. Unfortunately, the main engineering design rules and prediction models for drag-out which are currently in-use are inaccurate [2] and do not take into account recent scientific advancements in the active field of wetting phenomena.

In this work we present the outline of a comprehensive and integrated Course for the drag-out issue in Special Processes, applicable for continuing education Curricula [3]. This has been developed in Hellenic Aerospace Industry, within the Education Curriculum offered to external customers. The course outline for the Drag-out will be presented as well as the practical exercise in the laboratory. Drag-out measurements from metallic coupons taken from various process steps are presented [4,5], thus elucidating the effect of the surface roughness, surface chemistry and the related wetting phenomena. Cases in which the main prediction models fail are being also demonstrated.

**KEYWORDS:** Special Processes, Drag-out, Teaching, Wetting phenomena, Continuing Education

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