Evolutionary support vector machines for regression applied to the prediction of the thickness of the chromium layer in a hard chromium plating process

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Abstract

The hard chromium plating process aims at creating a coating of hard and wear-resistant chromium with a thickness of some micron directly on the metal part without the insertion of copper or nickel layers. It is one of the most difficult electroplating processes due to the influence of the hydrogen evolution that occurs on the cathode surface simultaneously with the chromium deposition. Chromium plating is characterized for high levels of hardness and resistance to wear and it is thanks to these properties that they can be applied in a huge range of sectors. Resistance to corrosion of a hard chromium plate depends on the thickness of the coating, adherence and micro-fissures of the latter. This micro-fissured structure is what provides the optimal hardness of the layers. The electro-deposited chromium layer is not uniformly distributed. In particular, there are zones such as sharp edges or points where deposits are highly accentuated, while deposits are virtually nonexistent in holes or in the undercuts. Hard chromium plating process is one of the most effective ways for protecting the base material against hostile environment or improving surface properties of base material. However, in electroplating industry, electro-platers are faced with many problems and undesirable results on chromium plated materials. Problems such as matt deposition, milky white chromium deposition, rough or sandy chromium deposition, insufficient thickness and hardness are the most common problems faced in the electroplating industry. Finally it must be remarked that defects in the coating decrease locally the corrosion resistance of the layer and that the decomposition of chromium hydrides causes the formation of a crack network in the coating.

This innovative research work uses evolutionary support vector regression algorithms for the prediction of the thickness of the chromium layer in a hard chromium plating process. Evolutionary support vector machines (ESVMs) is a novel technique that assimilates the learning engine of the state-of-the-art support vector machines (SVMs) but evolves the coefficients of the decision function by means of evolutionary algorithms (EAs). In this sense, the current research is focused in the estimation of the hyper-parameters that are required for the support vector machines technique for regression (SVMr) by means of evolutionary strategies. The results are briefly compared with those obtained by authors in a previous paper in which a model based on an artificial neural network was tuned using the design of experiments (DOE).