

USE OF EVOLUTIONARY ALGORITHMS FOR THE DESIGNING OF GAS NITRIDING PROCESS

Roman Olik, Jerzy Ratajski, Tomasz Suszko, Mateusz Kosikowski, Zbigniew Suszyński

The authors have undertaken a research task with a view to apply advanced mathematical modelling with the use of evolutionary algorithms for the designing of the course of a gas nitriding process, which guarantees obtaining the expected hardness profile in the layer nitrided. The gas nitriding process is widely used in industry in order to improve the functional properties of machine and tool parts.

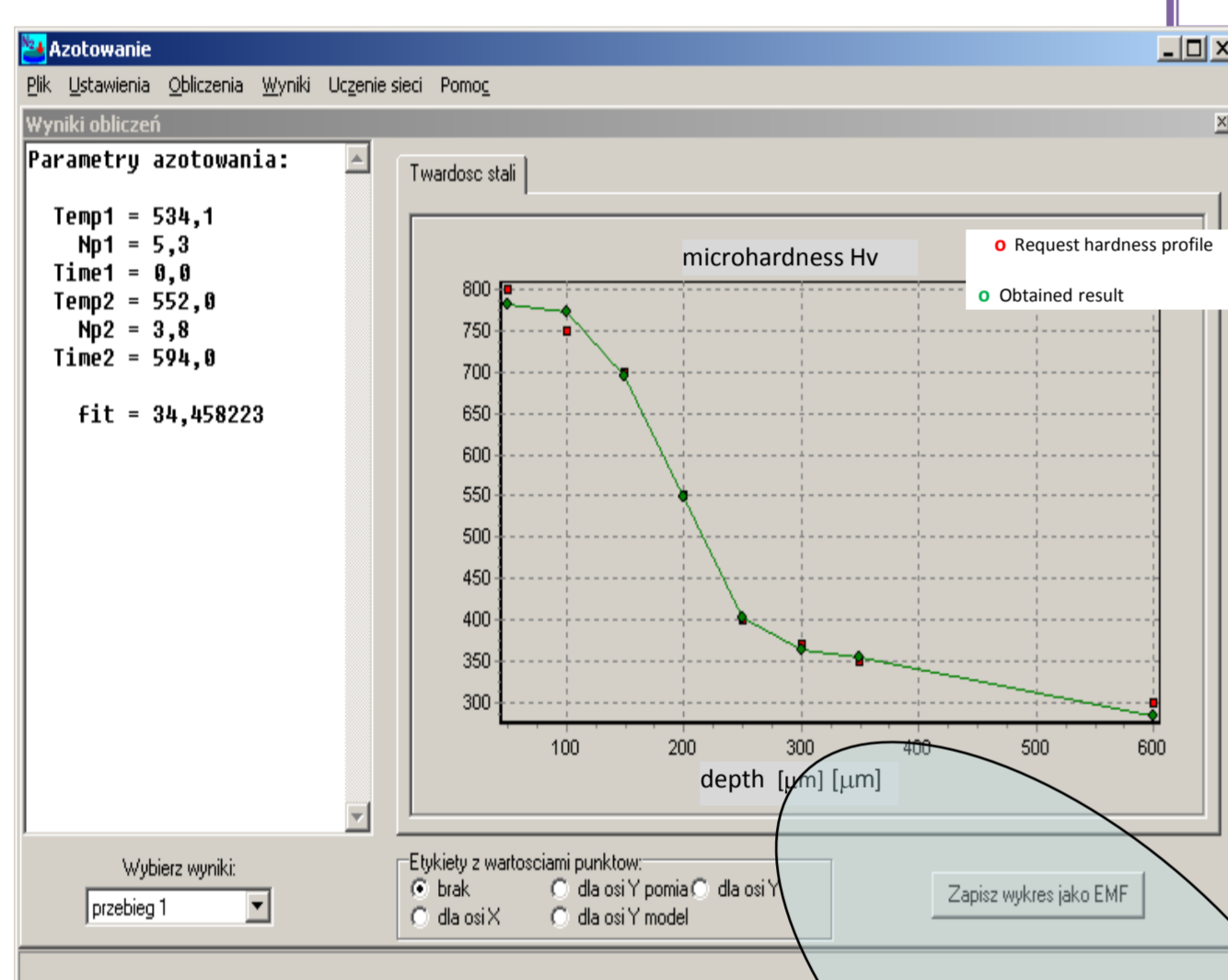
In the model developed, each chromosome includes encoded parameters of a single steel nitriding process. Chromosome sets form the so-called population. For each chromosome, a steel hardness profile related to it is determined. A trained neural network is used for this purpose. It performs the role of a model. Each chromosome (a set of parameters) is then evaluated: matching is conducted of its corresponding hardness profile to the profile sought.

On the further step, the chromosomes undergo a selection (selection of chromosomes with the best matching), a modification with the aid of crossing mutation operations and promotion to the next population. In this manner, by way of a directed evolution of steel nitriding parameters, such a set of these is selected for which the hardness profile matches best the profile sought.

Dataset of measurement nitriding
layer properties and processes

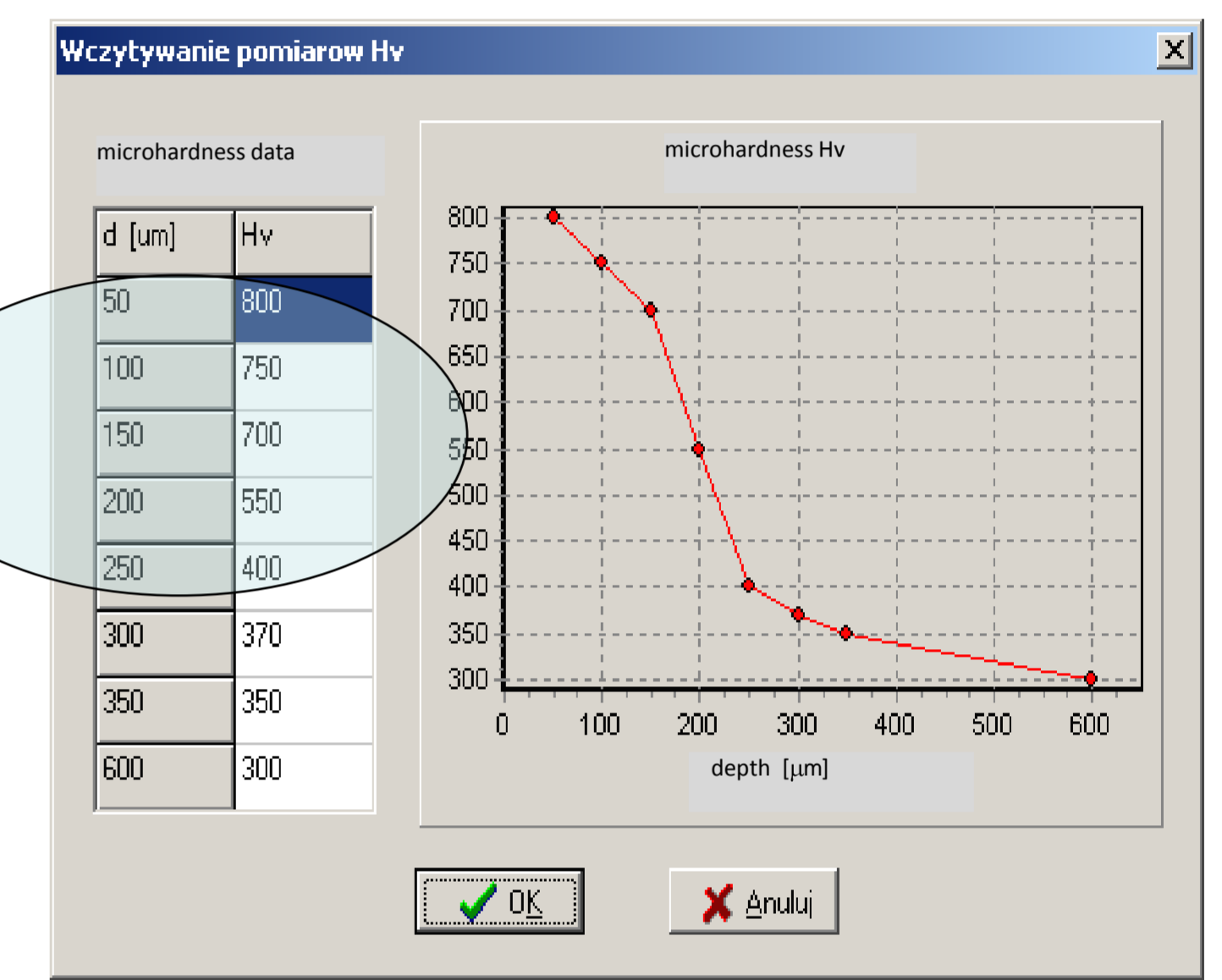
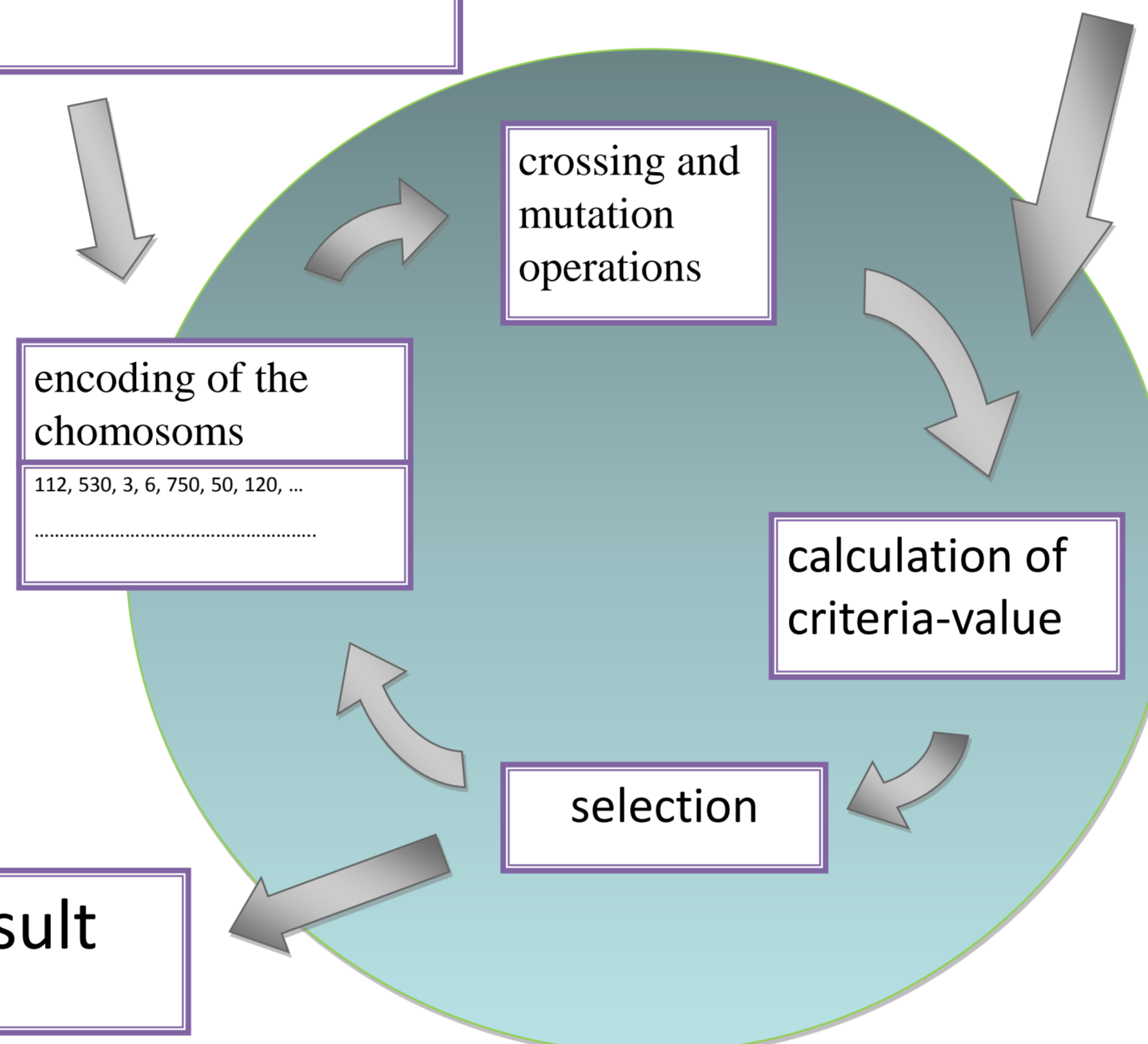
40H, 530°C, 3h, 6, Hv10-750, 50µm, 120µm, ...
40H, 530°C, 4h, 7, Hv10-780, 55µm, 130µm, ...

definition and
modification of
criteria



A window presenting the final result of the operation of the evolutionary algorithm: a set of process parameters which give as a result the profile which matches best the required profile.

result



Dialogue window for entering input data (hardness profiles) for an evolutionary algorithm of seeking optimal process parameters

Conclusions

The present article covers the concept of a model built on the basis of unconventional designing methods, artificial intelligence methods in application for the gas nitriding process being very popular in industry. The decision to consider these methods was justified by the problems connected with the modelling of the constitution processes of surface layers, which are the result of the variety of the mechanisms which accompany this process. Another reason was numerical limitations which occur during calculations with the use of analytical models.

The statistical model developed where evolutionary algorithms were used, makes it possible to determine the changes of the parameters of the gas nitriding process on the basis of the required hardness profile in the layer nitrided. The problem solved on the example of gas nitriding, i.e. determination of the process parameters which guarantee the required final result, constitutes one of the key issues of surface layer engineering.

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