# HYBRID GA-GRADIENT METHOD FOR THIN FILMS ELLIPSOMETRIC DATA EVALUATION

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In this work, we present application of a combined genetic-gradient algorithm in ellipsometry data analysis for samples with different structure complexity, starting with monolayer. We demonstrate that by using this method we are able to find material parameters even for limited a priori knowledge about the sample properties, where classical methods fail.

Traditionally gradient based minimization algorithms, such as Levenberg-Marquardt, are used as optimization tools in ellipsometric problems. However, similarly to other local optimizers, its performance depends on the complexity of the search space, the number of variables and a good starting point, being possible that the optimization would be trapped in a local minimum [1]. Because of the non-linearity and complexity of the model equations, the error surface in ellipsometry is mostly rough (Fig. 1). Therefore, more complex global-search optimization methods are desirable to overcome the problem of choosing initial values of the model parameters which are close enough to the real sample properties. Non-deterministic optimization algorithms, such as genetic algorithms [1], simulated annealing and others [2] have already demonstrated that in some cases they can be interesting alternative for gradient-based methods in ellipsometric data evaluation.

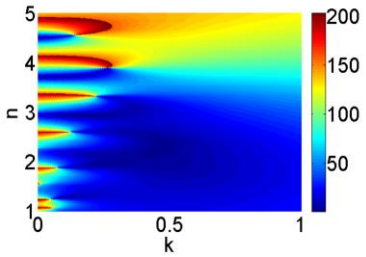


Fig. 1. An example error surface in ellipsometry: calculations for 200nm diamond-like carbon film ($n$ = 2, $k$ =0.25 @3.55 eV) on Si

Here we applied hybrid genetic-gradient algorithm. This method uses genetic algorithm (GA) concept to explore the objective space; hence do not make any assumptions about the underlying fitness landscape, avoiding the disadvantages of iterative improvement and, in particular, multiple descents by allowing the local search to escape from local optima. Afterward, the gradient-based algorithm is employed to explore promising part of the objective space. The method is able to determine all the parameters (complex refractive index, thickness) of any unknown layer and/or thicknesses of layers in case of a multilayer system, without need to deliver starting points.

*Keywords:* Thin films; Data evaluation; Genetic algorithm

**References**

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[2] O. Polgar, M. Fried, T. Lohner et. al., Surf. Science 457 (2000) 157-17.