XII International symposium on explosive production of new materials: science, technology, business and innovations (EPNM-2016)

Application of fractal analysis for assessment of the interlayer cluster formations at the interfaces in explocxlad multilayer structures

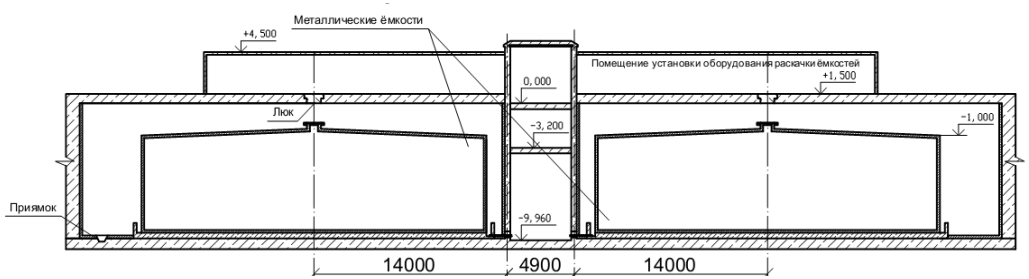
Rosen A.E.[(1)], Krevchik V.D.[(2)], Semenov M.D.[(2)], Pryschak A.V.[(2)], Rosen A.A.[(1)]

[(1)] Romet Ltd., 6 Drughba St., 440067 Penza, Russia
[(2)] Penza State University, 40 Krasnaya St., 440026 Penza, Russia

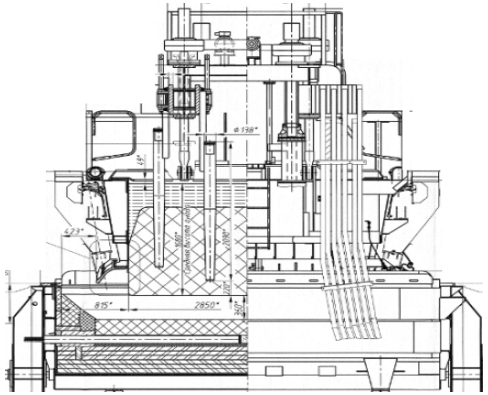
Coimbra, 2016

Relevance

The prospective of the transition from mono- and bimetallic material to multi-layer materials with an internal protector



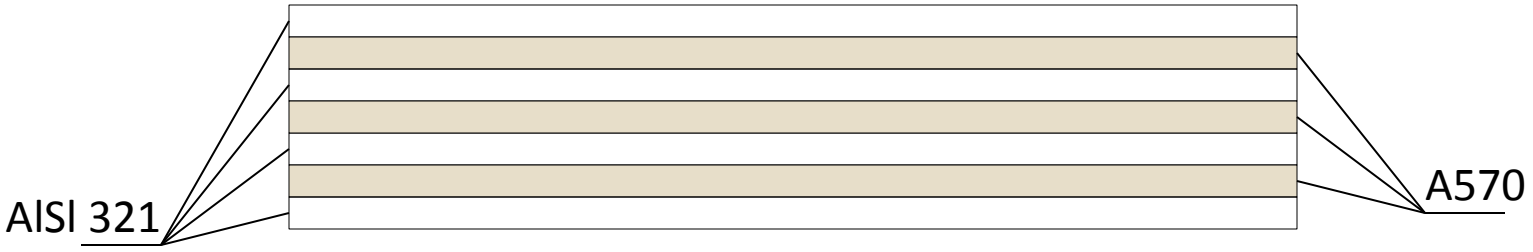
Design of LRW storage

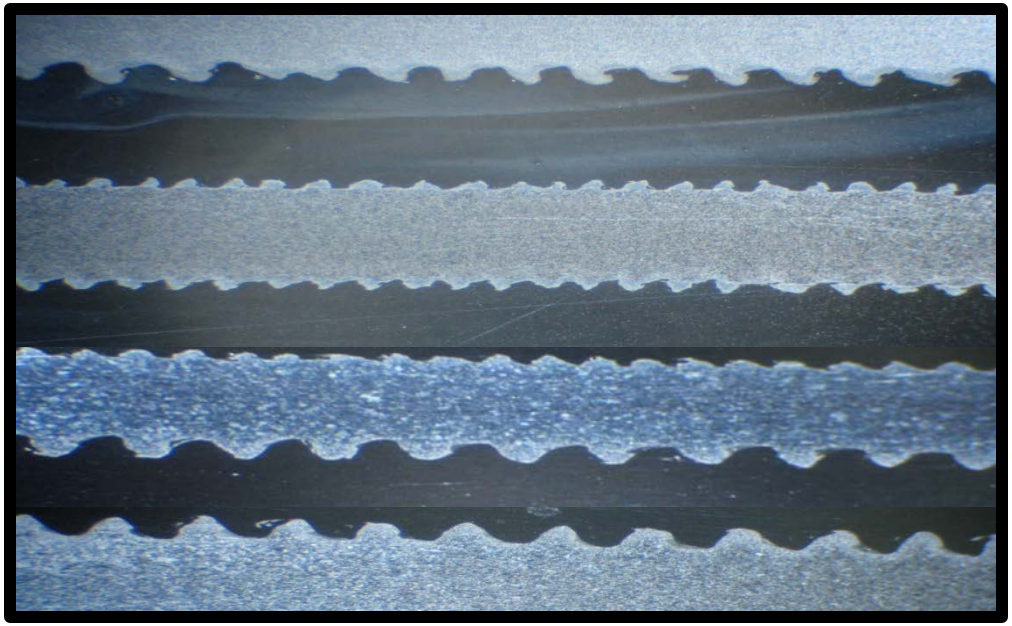


Electrolyzer design

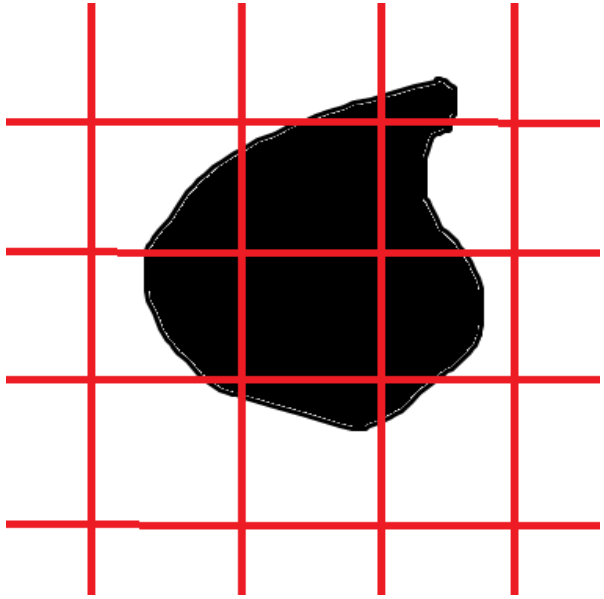
LRW storage		Electrolyzer	
Service life, years		Service life, years	
Basic version	Proposed version	Basic version	Proposed version
50	more than 150	2	more than 8

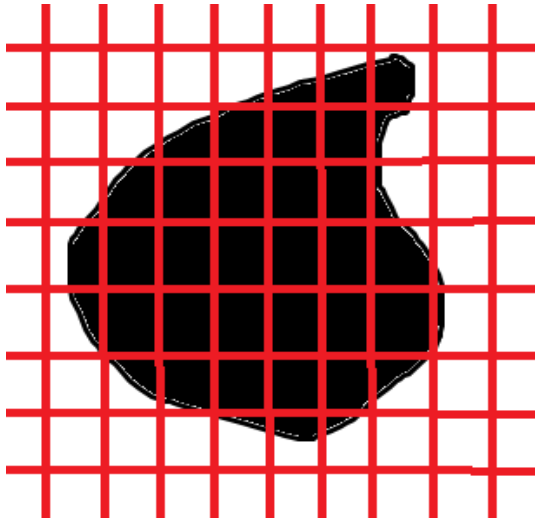
An example of a multilayer structure





Method of detecting fractal dimensionality





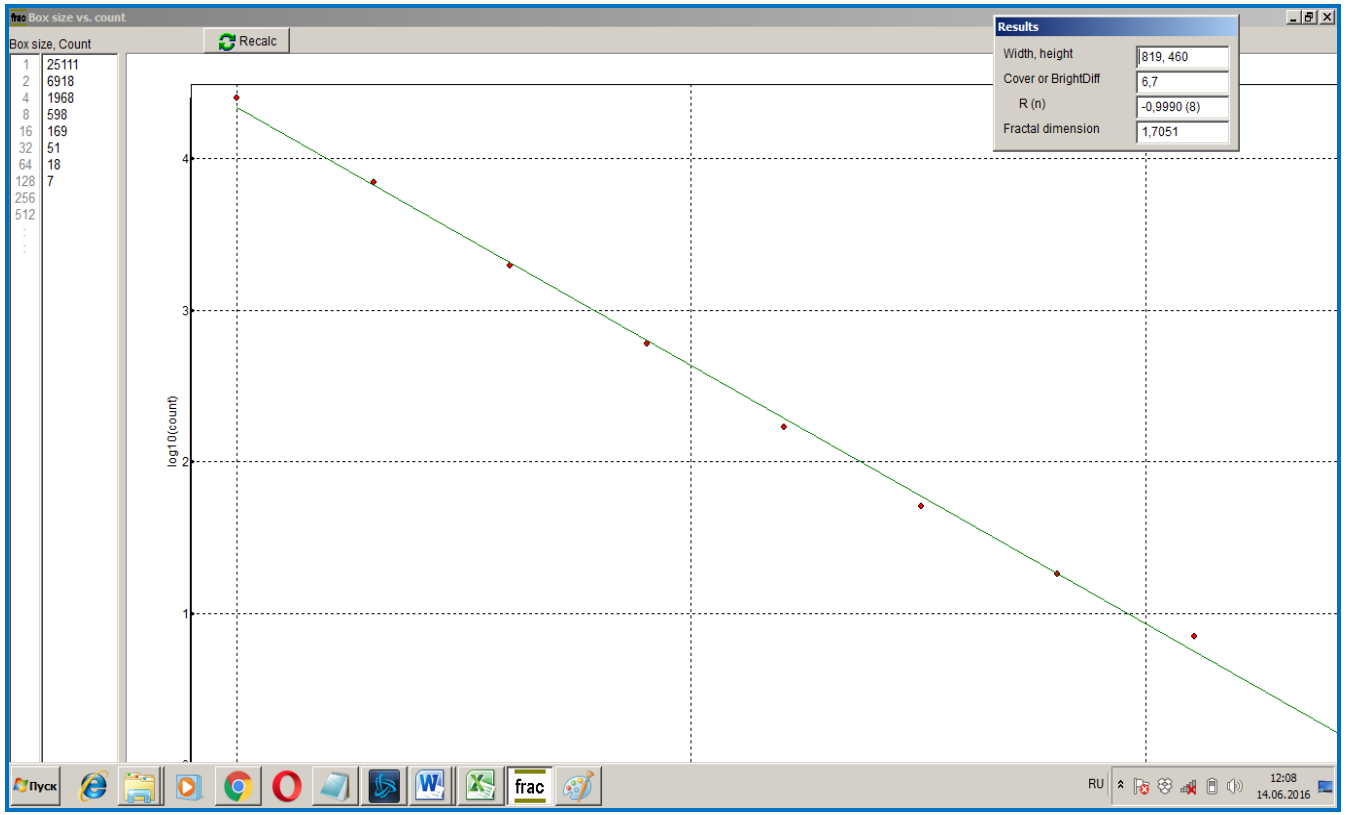
Hausdorff formula to determine the fractal dimensions:

$$d = \lim_{\varepsilon \to 0} \frac{\ln N_\varepsilon}{\ln \frac{1}{\varepsilon}}$$

N_ε – the number of squares, at least partially overlapping treated microstructure;

ε – one side of a square size.

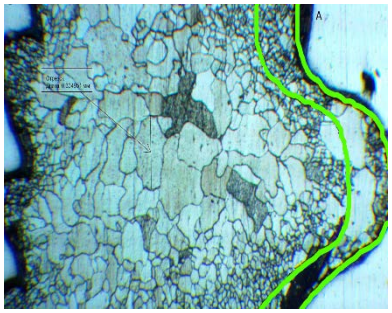
Calculation of fractal dimensionality



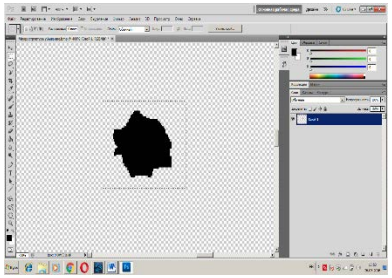
Calculation of the fractal dimensionality of Hausdorff is based on a graph of relation of the logarithm of the number of cells to the logarithm of the inverse of their size.

Stages of calculation

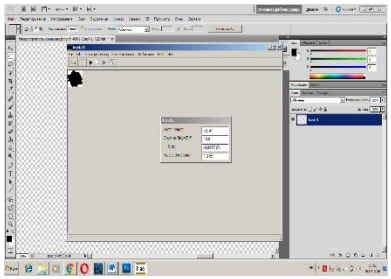
Step 1



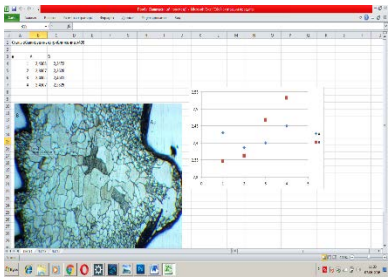
Step 2



Step 3



Step 4



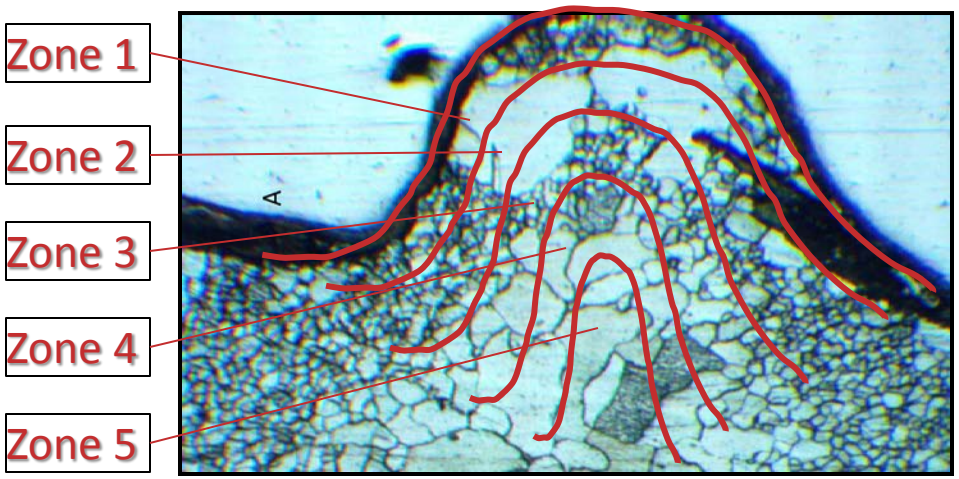
Step 1: Processing of the original picture by means of graphical editing.

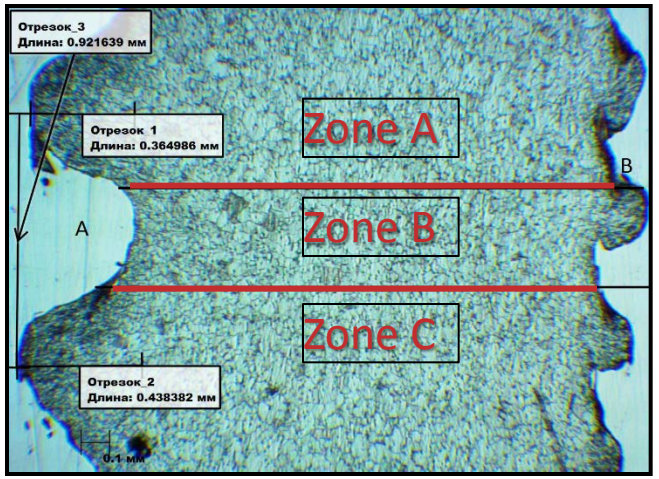
Step 2: Using image processing means for highlighting of a single microstructure in black.

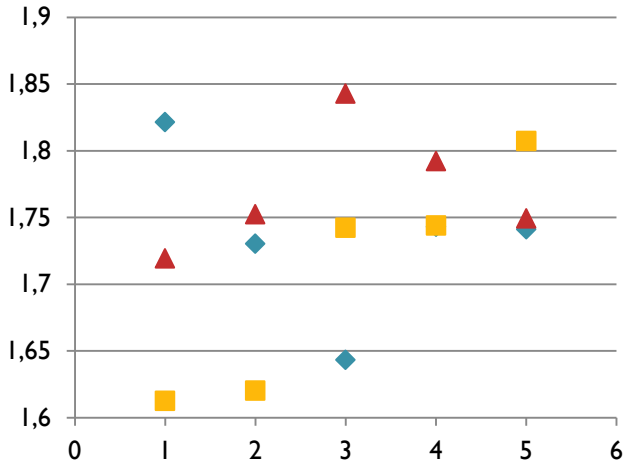
Step 3: Calculation of the dimension with the help of a special program. This step must be performed for structures specified in step 2, and get the average dimensionality of the layer.

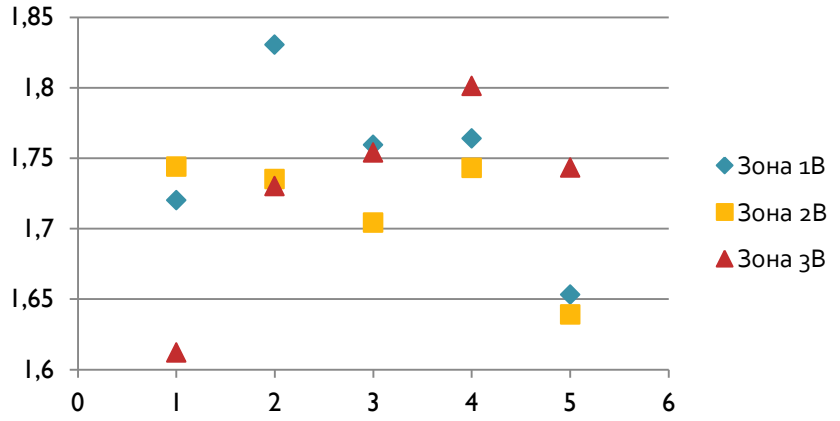
Step 4: Repeat steps 1-3 for each layer and record the results in any convenient information-processing software.

Zonal division of the microstructure









Advantages of Fractal Analysis

The fractal dimensionality is sensitive both to external parameters and influences, and internal characteristics of the material.

There is a correlation between the mechanical properties of each of the layers and the size of the dimension of fractals.

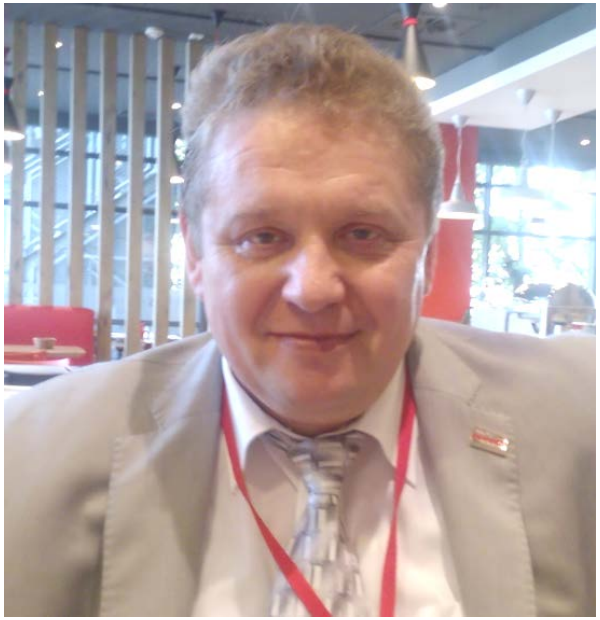
In combination with mathematical modeling of processes of formation of structure it can allow us to predict the optimal parameters of explosion welding of thin sheet metal laminated with inner protector and significantly reduce the number of experiments.

Appreciation note

I express great gratitude to Professor Hiroyuki Sasaki (National Institute of Livestock and Grassland Science, Nasushiobara, Tochigi, 329-2793, Japan)

for the opportunity to use copyrighted software to determine the fractal dimensionality of the samples.

Thank you for attention!



E-mail: aerozen@bk.ru

Tel.: +7 927 380 93 81