



—

- Nanocapillary

μ

MIS 375233

Η μ (simulation) μ μ μ μ

μ , μ

μ . μ μ μ μ μ μ

μ μ ( μ , μ , μ μ ,

μ ) μ μ . μ

μ μ μ

μ μ «μ μ » μ

μ

μ μ μ μ μ μ

μ μ μ μ μ μ μ μ

μ . μ μ μ μ ,

μ μ μ μ ( μ μ

). μ μ

, μ μ

μ μ . μ μ μ

μ

μ μ

- μ μ ( . . μ μ )
- μ μ μ μ
- μ μ μ

μ μ ( μ μ μ μ μ μ

μ μ μ )

▪ μ , μ μ μ

▪ μ

▪ μ

μ ,

μ , μ , μ

μ . μ

μ μ

μ . μ

μ μ μ μ . μ

μ . μ

μ μ μ μ μ μ

( ) μ

μ μ

μ .

μ

μ

μ .

μ μ - μ μ

μ - μ μ .

μ μ

μ μ :

1. μ μ μ .

μ μ μ , μ 16

μ . μ μ μ





- 2.
- 3.
- 4.
- 5.
- 6.
- 7.



μ μ μ μ μ  
μ μ μ μ μ  
μ μ μ μ μ  
μ μ μ μ μ

- μ μ :
1. μ ( μ )
  2. μ ( μ , μ )
  3. μ μ ( , μ )
  4. μ μ ( , μ , )
  5. ( μ , , marketing).

μ μ μ μ μ

### MONTE CARLO

Monte Carlo μ μ μ  
μ μ μ , ο μμ  
μ μ μ 1944  
μ μ μ μ μ

μ **Monte Carlo** μ \_\_\_\_\_ μ  
μ μ μ μ μ  
μ . Monte Carlo μ μ  
\_\_\_\_\_ μ μ \_\_\_\_\_ μ .



μ μ μ — μ , Monte Carlo μ  
μ \_\_\_\_\_ Monte Carlo μ  
μ  
μ μ μ μ .  
Monte Carlo μ μ μ  
μ μ μ μ \_\_\_\_\_ μ μ , ,  
μ , μ . , Monte Carlo  
μ μ μ μ μ μ  
\_\_\_\_\_ μ , μ  
\_\_\_\_\_ μ . μ μ  
μ μ . μ ,  
μ μ μ μ .  
μ μ μ μ  
μ μ μ μ .

Monte Carlo μ μ μ  
μ , μ μ ,  
μμ  
μ , μ  
μ .

## NANOCAPILLARY

μ μ 2D , (porosity)  
(autocorrelation), μ μ I(q)  
.  
μ  
(Stochastic Reconstruction) 3D μ , μ

μ 2D .  
 [1].  
 : 1) μ (μ μ 0  
 1) μ μ 3D μ 2) μ  
 μ Hermite, 3) μ  
 μμ 3D  
 μ , 2D .  
 3D μ  
 μ 2D  
 μ μ 2D μ ,  
 μ (SAXS) μ I(q) , μ  
 (r) [2]. ,  
 I(q), μ μ (r) μ  
 [2] .  
 μ MATLAB  
 (rapid prototyping).  
 μ , μ μ  
 3 μ μ  
 (Stochastic Reconstruction) [1]. μ  
 μ μ μ μ μ  
 , .  
 μ , μ  
 μ μ « μ Joshi–Quiblier–Adler»  
 (JQA). μ μ  
 :



1.  $\mu$   $3 \mu$   $N(x, y, z) \mu$  Gaussian  
 Box-Muller  $\mu$   $\mu$   $\mu$  .

2.  $\mu$   $\mu$   

$$F(r) = F(x, y, z) = \frac{S_2(r = \sqrt{x^2 + y^2 + z^2}) - S_2(0)^2}{S_2(0) - S_2(0)^2}$$
  
 $S_2(r)$   $2 \mu$   $2D$  .

3.  $3 \mu$   $\mu$   $(\mu)$ ,  
 :

$$R(x, y, z) = \sum_{i=0}^c \sum_{j=0}^c \sum_{k=0}^c N(x+i, y+j, z+k) \times F(i, j, k)$$

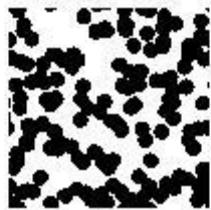
4.  $\mu$   $\mu$   $3D$   $(R) \mu$  Gaussian  
 .

5. (thresholding)  
 $3D \mu$   $(e) \mu$   $2D$   
 .

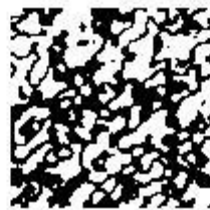
$\mu$  MATLAB  
 (rapid prototyping).

$\mu$  **1:**

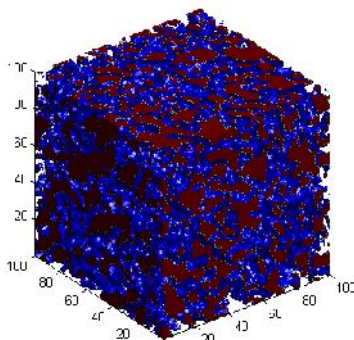




( )



( )



( )

1: ( ) 2D , ( ) μ 3D  
 μ ( ) μ 3D μ .  
 μ μ μ 3  
 μ μ μ Joshi–Quiblier–Adler»  
 (JQA). μ μ μ μ  
 μ , μ  
 μ μ (01/5-31/5).  
 μ μ  
 μ 3 μ

μ «On 3D Reconstruction of Porous Media by Using Spatial Correlation Functions», :



$\mu$   $\mu$  ,  $3$  ( )

$\mu$  ,  $3$   
 $\mu$   $2$  .

$\mu$  ( )  
 :

$$R_z^1 = \frac{\langle (Z(\mathbf{x}) - v) \cdot (Z(\mathbf{x} + \mathbf{u}) - v) \rangle}{\langle (Z(\mathbf{x}) - v)^2 \rangle}$$

$\mu$   
 $\mu$   $\mu$   $\mu$  ,  $\mu$   
 $\mu$  .

$\mu$  ,  $\mu$   $\mu$  : Genetic Algorithms (GAs), Particle Swarm Optimization (PSO), Differential Evolution (DE), Firefly Algorithm (FFA), Artificial Bee Colony (ABC), Gravitational Search Algorithm (GSA).

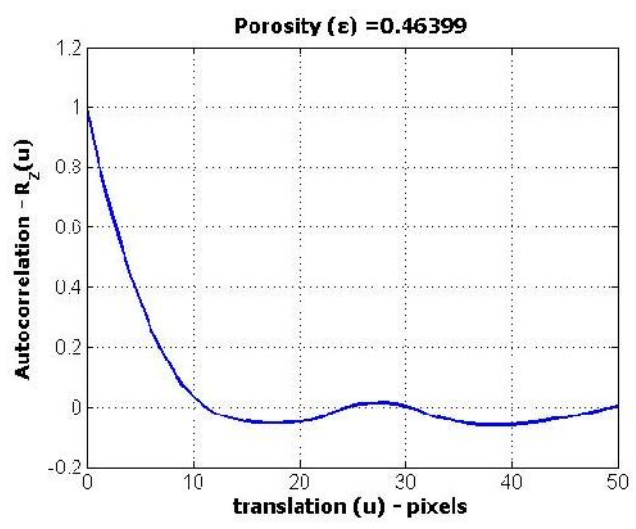
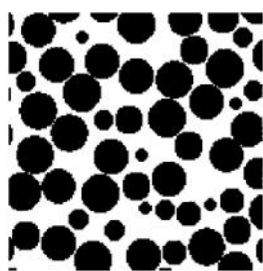
$\mu$   $\mu$   $\mu$   
 ,  $\mu$   $\mu$  .  
 $\mu$  ,  $3D$  ,  
 $\mu$   $\mu$   $2D$  (  $\mu$  ) ,  $\mu$   
 $\mu$   $\mu$  .

: 1)  
 $\mu$   $\mu$   $\mu$  , 2)  
 3)  $\mu$  ( - porosity) ( $R_z$ )

$\mu$  .  
 $\mu$   $3D$   $\mu$   $\mu$  .

$I(q)$

MATLAB  
(rapid prototyping),



(autocorrelation),  $I(q)$

- 1) Hermite, 3D
- 2)
- 3)

2D

μ  
(rapid prototyping).

MATLAB

[1] M.E. Kainourgiakis, E.S. Kikkinides, A.K. Stubos, “Diffusion and Flow in Porous Domains Constructed Using Process-Based and Stochastic Techniques”, *Journal of Porous Materials*, vol. 9, no. 2, pp. 141-154, 2002.

[2] Karthik K. Bodla, Suresh V. Garimella, Jayathi Y. Murthy, “3D reconstruction and design of porous media from thin sections”, *International Journal of Heat and Mass Transfer*, vol. 73, pp. 250-264, 2014.

[3] C.L.Y. Yeong and S. Torquato, “Reconstructing random media”, *Physical Review E*, vol. 57, no. 1, pp. 496-506, 1998.

[4] C.L.Y. Yeong and S. Torquato, “Reconstructing random media. II. Three-dimensional media from two-dimensional cuts”, *Physical Review E*, vol. 58, no. 1, pp. 224-233, 1998.

[5] G.A. Papakostas, J.W. Nolan, N. Vordos, D. Gkika, M.E. Kainourgiakis and A.C. Mitropoulos, “On 3D Reconstruction of Porous Media by Using Spatial Correlation Functions”, *Journal of Engineering Science and Technology Review*,