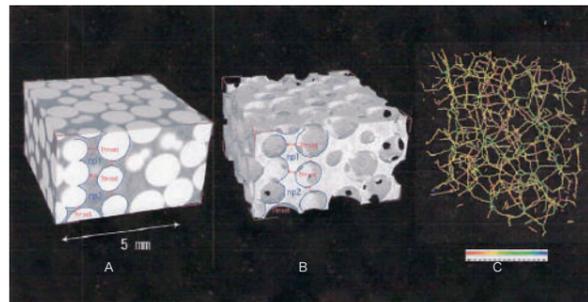


Three-dimensional Image Analysis Software

# ExFact Analysis for Porous/Particles

Analyzing the network structure of porous media and particles

Processing a volume data of 1mm diameter glass beads

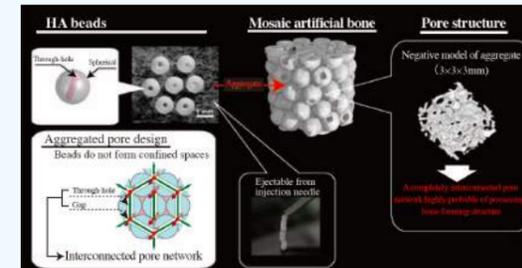


A: CT volume data  
B: extracting the void space  
C: after the thinning process

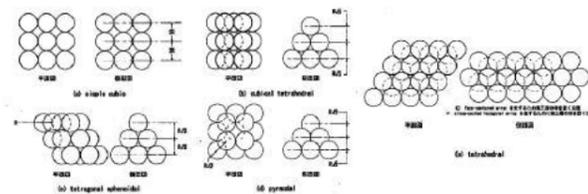
Case Example

Dr. Kei Teraoka,  
Advanced Manufacturing Research Institute,  
The National Institute of Advanced Industrial  
Science and Technology

In the field of regenerative medicine, porous ceramic is attracting attention as a promising candidate material for artificial bone. Dr. Teraoka has developed the "mosaic artificial bone," a cylindrical cell filled with spherical apatite beads. The three-dimensional structure made up of close-packed spheres does not form closed cavities, which means biologic factors, including osteocyte and blood, can easily access inside and flow through, thereby promoting favorable bone formation. As a part of material evaluation, Dr. Teraoka uses ExFact Analysis to conduct quantitative structural analysis on the 3D images of bone regeneration materials obtained with microfocus X-ray CT.



Close packing of spheres



Application Fields

Material engineering in general

including petroleum, rubber, plastics, resin, polymer, granules (dosage form), methane hydrate, concrete/gravel, fuel cell, carbon nanotube, paper, pulp fiber, ceramic, catalyst, bone, dental/medical material, precision/electronic component, semiconductor.

Input data format

A series of tomographic image obtained through imaging devices such as X-ray CT, CLSM and TEM tomography

Before conducting 3D image analysis on ExFact Analysis, the image stack needs to be preprocessed, including the extraction of the region of interest, on ExFact VR. ExFact VR supports various file formats including tiff, bmp, dicom and original forms of different devices.

ExFact® Analysis Product Lineup/ Specification Details

Product Lineup

- ExFact® Analysis for Porous/Particles
  - ExFact® Analysis for Fiber
- Please use either or both, depending on the types of object materials.

Required Software

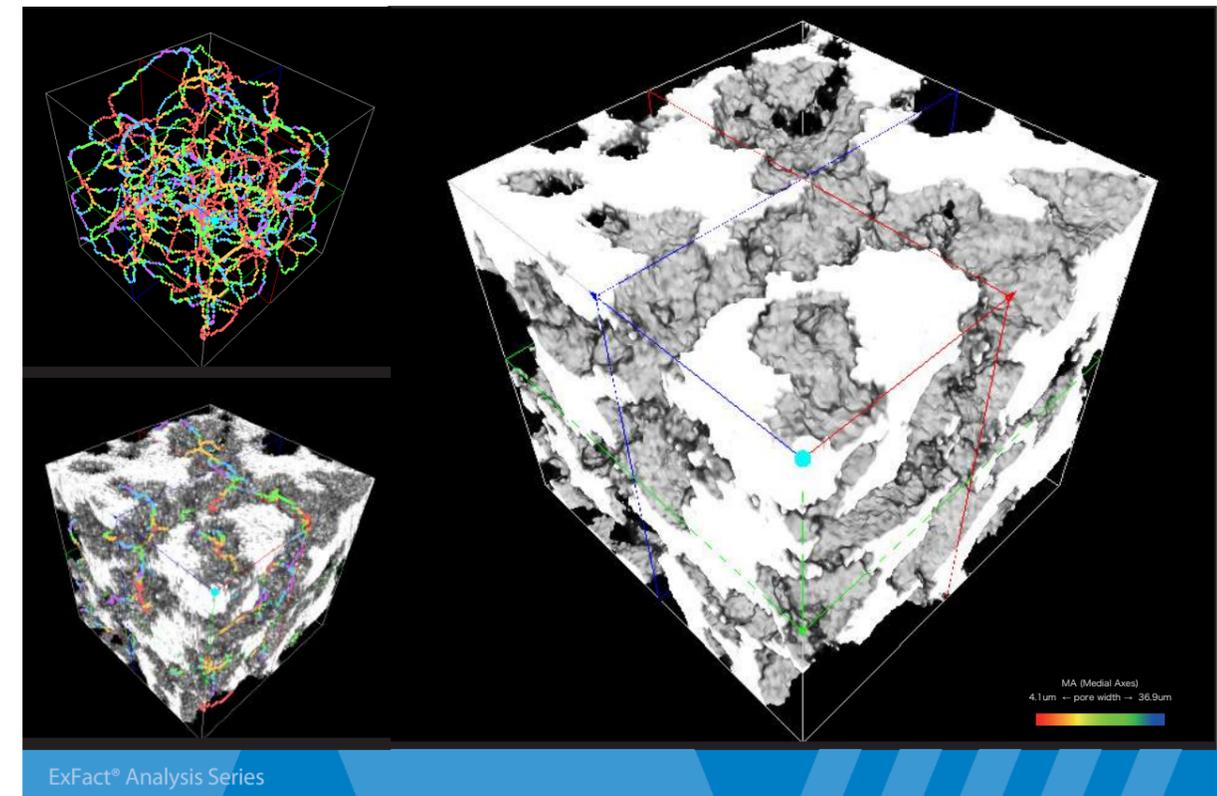
- Exfact® VR Windows (64-bit version)
- \* for preprocessing and rendering/display of image data.

Software Licensing

- USB Software Protection Device

System Requirements

- Operating System : All editions of Microsoft Windows 7/8, Japanese/English versions supported.
- At least 4GB of RAM
- 1280 x 1024, full color screen resolution or higher
- A USB port (for USB Software Protection Device)



ExFact® Analysis Series

Visualize your imagination

Specification and release time may change without notice. Company and product name are registration of trademark.

**NVS** Nihon Visual Science, Inc.

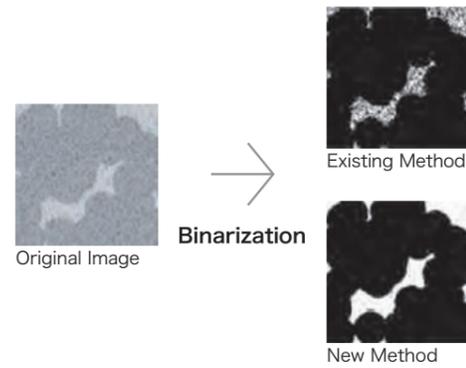
<http://www.nvs.co.jp/> [info@nvs.co.jp](mailto:info@nvs.co.jp)

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Imaging technologies such as X-ray CT, CLSM and TEM tomography provide a series of tomographic image of industrial products and materials for the construction of their 3D images. ExFact® Analysis, a software based on the novel concept of "Medial Axis" to capture the complex structure of various objects, offers a tool to conduct statistical evaluation/analysis on the properties of those 3D images, including shapes/distributions of grains/voids, as well as orientations of fibers.

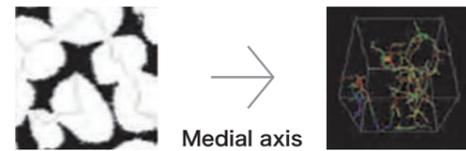
Basic Concepts



Newly Developed Segmentation Process

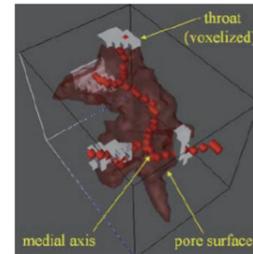
A cross sectional (tomographic) image obtained with imaging devices, such as X-ray CT, basically consists of pixels of various gray values. Each of these pixels represents the corresponding point of imaged object, with their gray values corresponding to the material density of the points. On a digital image, whose spatial resolution has a certain limitation, the intensity values of marginal region become lower than their true values (which is called "partial volume effect"). This effect, along with noises and artifacts, makes it difficult to obtain an ideal image in which material phase and pore space are clearly separated.

Equipped with a newly developed segmentation algorithm, ExFact Analysis carries out binarization process based on its three-dimensional scanning of highly-intricate material/void-space structure. The software sets two thresholds (high and low) on a 3D image histogram, where the voxels with gray values higher than the high threshold are classified into material phase, while those with lower values than the low threshold into void space. Those with in-between gray values are classified into either of the two categories after the software statistically processes the gray values of their neighbouring voxels, providing more probable contour estimation. The resultant output file after the segmentation can be used on ExFact® VR for further image processing.



Medial axis

ExFact Analysis constructs the "Medial Axis" of the object - skelton of void space represented in a union of one dimensional curves. This lower dimensional representation of the object, while preserving important geometric properties, is easier to analyze than a 3D image. ExFact Analysis uses the medial axis as the basis for understanding the complicated 3D properties of the original object.

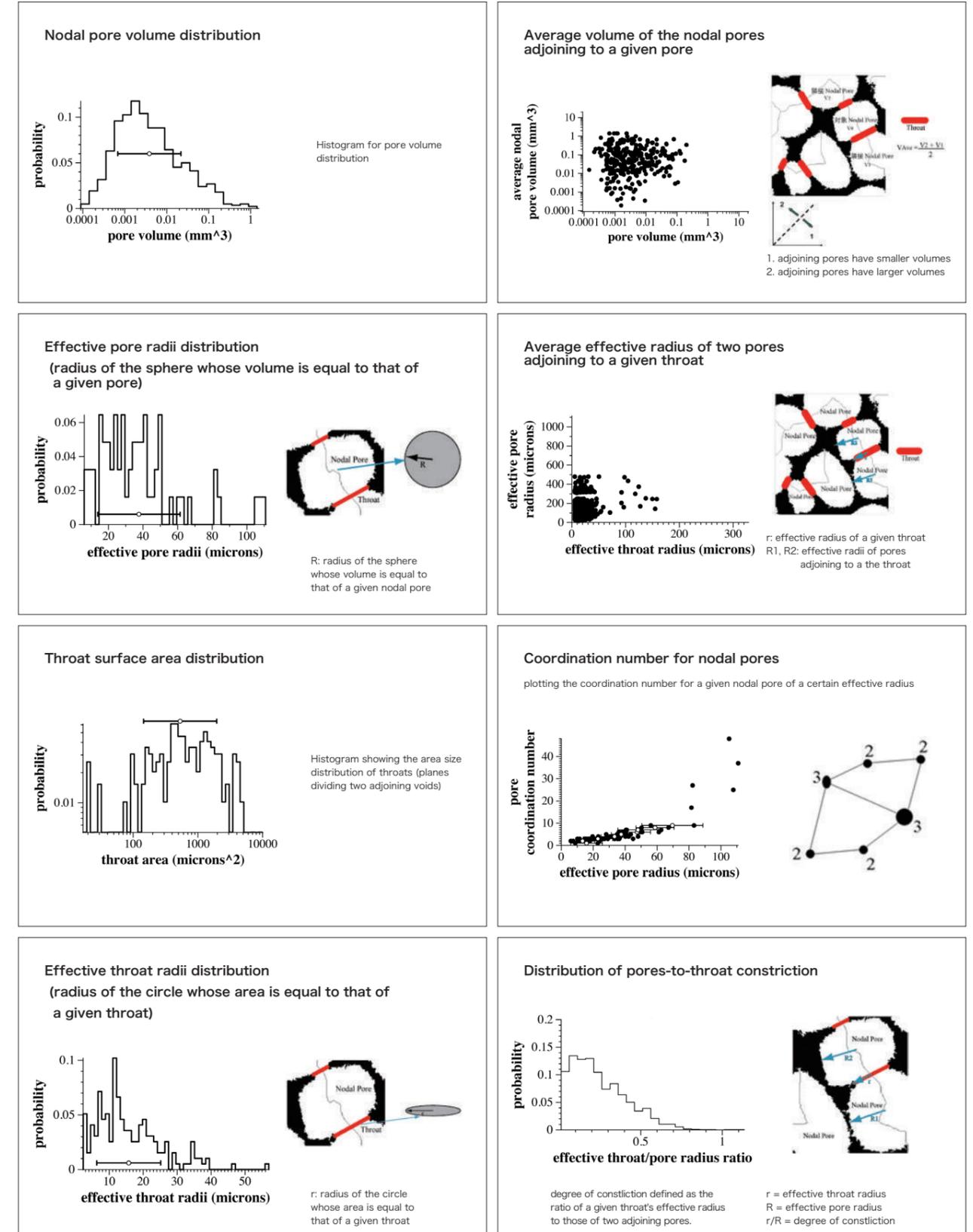


Analyzing the 3D structure of porous media

The void space structure of a porous media has a complicated 3D structure. First step of the analysis is the thinning (skeltonization) of the void space and the construction of the medial axis. The medial axis represents the continuum of void space. Next step is to identify throats, the most constricted part on each pathway, which can be likened to a door placed between two rooms. Throat area size determines the permeability of fluids. Nodal pores are defined as the void spaces divided by throats. ExFact Analysis analyzes the properties of porous media based on those pores and throats.

Graphs Plotted Based on Analysis Results

ExFact Analysis calculates various statistical values for material evaluation.



Flow Steps

