Supporting information for

Image-based method for obtaining pore-size distribution of porous biomasses

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This 9-page Supporting Information contains two parts and eight figures

PART I: METHOD VALIDATION

Test Example 1 is an extremely simple geometry composed of several individual circles having different diameters, as shown in Figure S1 (a). There are one 260 pixel-diameter circle, one 160 pixel-diameter circle, two 140 pixel-diameter circles, two 100 pixel-diameter circles, five 80 pixel-diameter circles, three 70 pixel-diameter circles and five 30 pixel-diameter circles. The theoretic PSD of this geometry should have peaks at the seven diameters, indicating that seven pore sizes exist, while remains zero area at other pore sizes. Figure S2 shows a comparison between the theoretical result and that obtained by the proposed method, which shows a very good agreement. Figure S1 (b) shows the pattern of pore areas of different diameters. Different gray levels indicate different pore sizes, as indicated by the legend bar on the right of the figure.

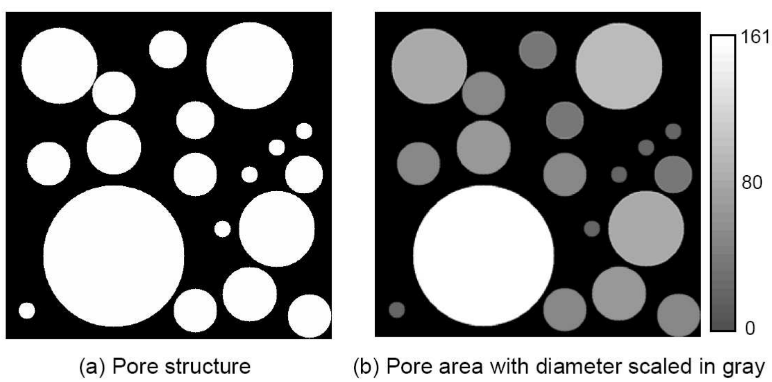


Figure S1. Validation – example 1: separated circles

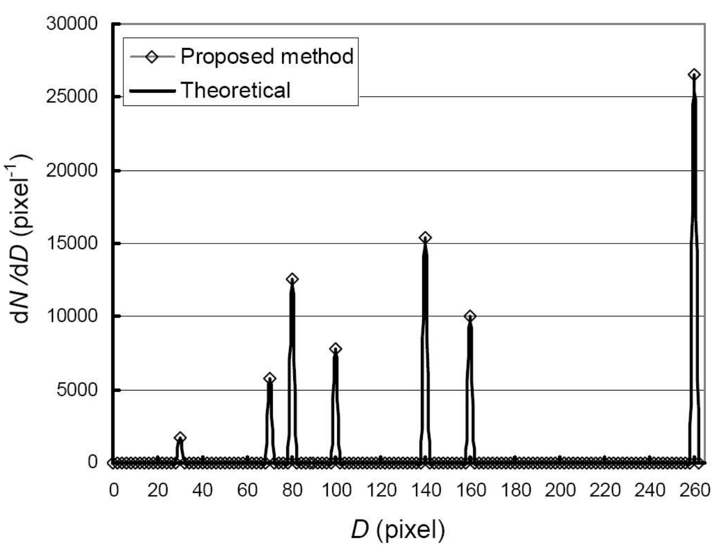
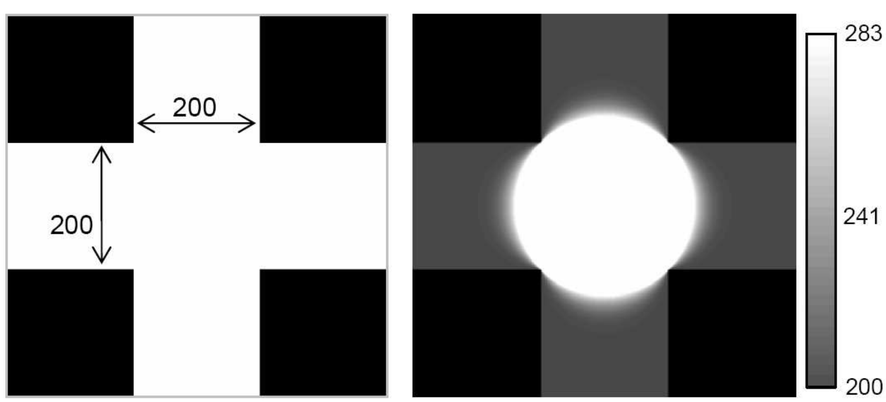


Figure S2. PSD of example 1 (*N* pixel number, and *D* pore diameter)

A non-trivial test structure, or Example 2, is an inter-cross channel, as shown by Figure S3 (a). This geometry is difficult in determining PSD due to the connection among pores. Figure S3 (b) shows the pore pattern of different sizes determined by the proposed method. The largest pore is located at the center of cross, as indicated by the white area in the figure. As the gray fades into the four channels, the area of pores with decreasing diameter is located in the adjacent region of the largest one. The area of the smallest pore exists only in the four channels and has the grayest area value, as shown in Figure S3 (b). Since the configuration here is relatively simple, it is possible to imagine the filling process of mercury, as in the MIP, into the pore structure. The center region of cross is first occupied by mercury with a curvature of large diameter R_1 (Figure S5 (a)); as the curvature diameter decreases, the area in the four channel with smaller diameter can be included, as shown in Figure S5 (b) and (c). Knowing the evolution of the shape of the enclosure of mercury, the area occupied by mercury at each curvature radius can be theoretically calculated. This theoretic calculation is used to compare with the results obtained by the proposed method (Matlab program), as shown in Figure S4, which shows a good agreement.



(a) Pore structure (b) Pore area with diameter scaled in gray

Figure S3. Validation – example 2: cross channel

In Figure S4, two peaks appear at diameter of 200 and 283, representing the characteristic pore area in the four channels and at the inter-cross center, respectively. The deviation of the results predicted using Matlab program from the theoretic one in the region between D = 200 and 280 is caused by the discrete datum format of digital figures. The figure used for validation of the program has a resolution of 600×600 pixel^2. If a figure of higher resolution is used, the difference between the proposed method and the theoretic calculation can be effectively suppressed. Compared with the main pore volumes at the two peaks, the deviation magnitude is quite small, much lower than 1%.

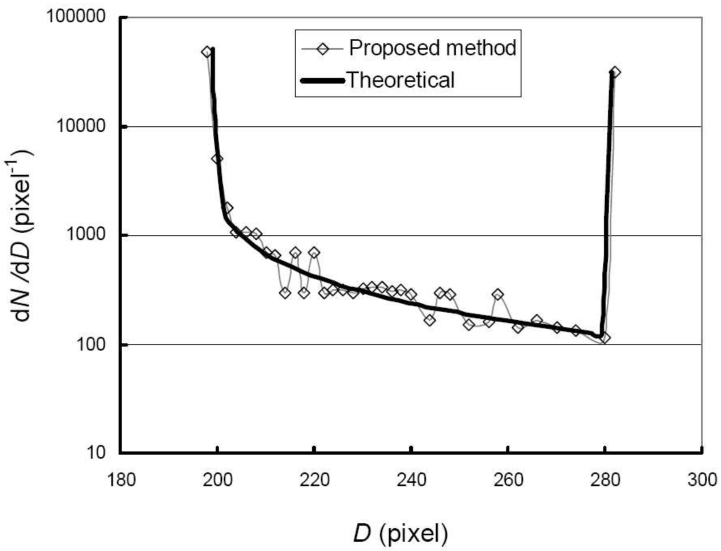


Figure S4. PSD of example 2 (*N* pixel number, and *D* pore diameter)

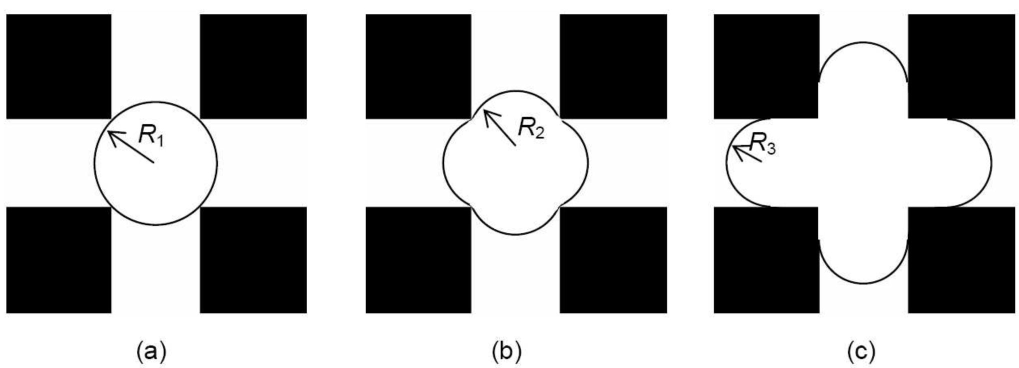


Figure S5. Calculation of pore distribution: $R_1 > R_2 > R_3$

Test Example 3 is a step channel composed of a large and a small channel, as shown in Figure S6 (a). This pore structure is typical for illuminating the principle of mercury intrusion porosimeters and is frequentely encountered in practical applications. Figure S8 illustrates the evolution of mercury enclosure shape during the intrusion process of MIP. As in the previous example, the theoretical calcualtion of PSD is performed by knowing the shape of mercury occupation at differnt curvature radius. Figure S7 presents the results obtained by the proposed method (Matlab program) and the theoretical method. The two peaks at diameter of 200 and 400 in Figure S7 correspond to the 200-pixel-wide channel of and the 400-pixel-wide channel, respectively. Pore volume at diameter smaller than 200 locates in the two corners on the large channel side, as shown by the grayest region in Figure S6 (b), and pore volume having diameter between 200 and 400 is in the transitional region between the two channels. Similar to the previous examples, the deviation between the results of the proposed method and the theoretical calcualtion is introduced by the discrete image format and is far less than 1% of the two peak values.

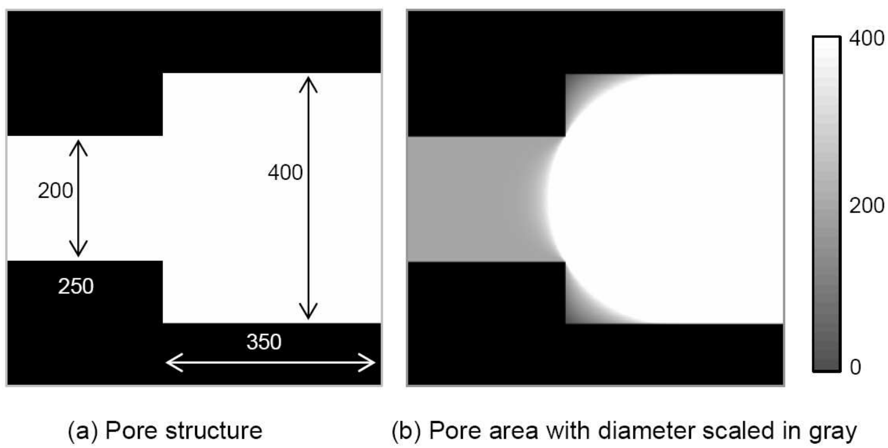


Figure S6. Validation – example 2: cross channel

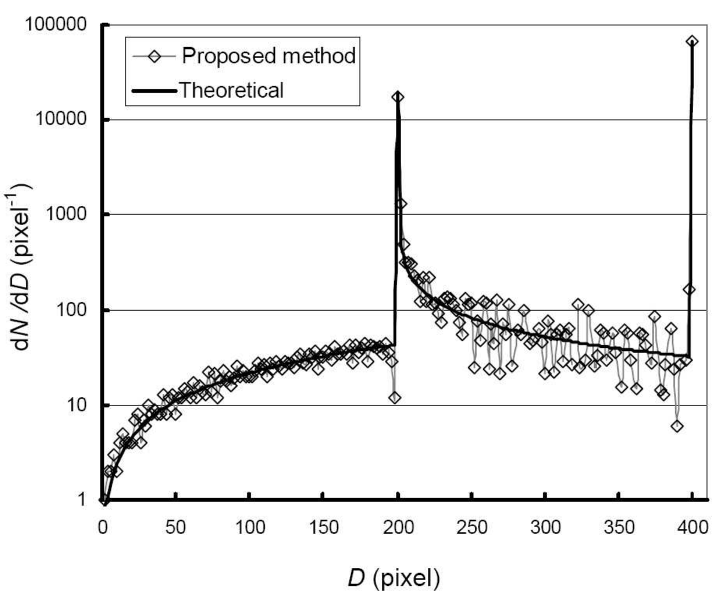


Figure S7. PSD of example 3 (*N* pixel number, and *D* pore diameter)

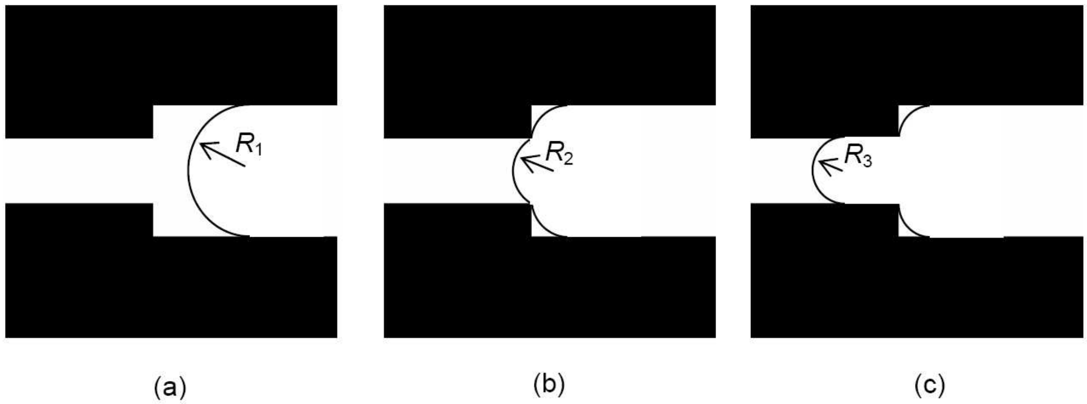


Figure S8. Calculation of pore distribution: $R_1 > R_2 > R_3$

PART II: MATLAB™ PROGRAM

```
clear all;

a1=1;

a2=500; % pixel number in the x-direction

b1=1;

b2=500; % pixel number in the y-directioin

c1=1;

c2=40; % total number of the images in a series

Re(100)=0; % allocated stream for data storage

S1='G:\Fouling\S3\resized2\IMAGE'; % file name including storage path

S3='.tif'; % file suffix

for i=c1:c2 % begin reading the image series into a 3D matrix named “C”

   S2=int2str(i);

   if i<10;

      S=[S1,'0',S2,S3];

   end

   if i>9

      if i<100
```

```
            S=[S1,S2,S3];
        end
    end
    I=imread(S); % read image into Matlab
    C(:,:,i)=double(I); % turn image into matrix
end % finish reading here
C0=0*C;
C1=0*C;
for i=a1:a2 % begin to find the critic radius for each unit-valued pixel, and store the value of critic radius in the matrix "C0"
    for j=b1:b2
        for k=c1:c2
            if C(i,j,k)~=0
                mark=1;
                l=0;
                while mark>0,
                    C0(i,j,k)=l+0.5;
                    l=l+1;
                    if (i-l)<=(a1-1)||(j-l)<=(b1-1)||(k-l)<=(c1-1)||(i+l)>=(a2+1)||(j+l)>=(b2+1)||(k+l)>=(c2+1))
                        mark=0;
                    end
                    if (mark~=0)
                        foraa=(i-l):(i+l)
                            for bb=(j-l):(j+l)
                                for cc=(k-l):(k+l)
                                    if  sqrt((aa-i)^2+(bb-j)^2+(cc-k)^2)<=l
```

```
                if C(aa,bb,cc)==0
                  mark=0;
                end
              end
            end
          end
        end
      end
    end
  end
 end
end
end % finish the critic radius-finding procedure
dpm=max(max(max(C0)))-0.5;
for dp=dpm:-1:0 % begin to locate the surrounding pixels
  for i=a1:a2
    for j=b1:b2
      for k=c1:c2
        if C0(i,j,k)==dp+0.5
          for aa=(i-dp):(i+dp)
            for bb=(j-dp):(j+dp)
              for cc=(k-dp):(k+dp)
                if sqrt((aa-i)^2+(bb-j)^2+(cc-k)^2)<=dp
                  if C1(aa,bb,cc)==0
                   C1(aa,bb,cc)=dp+1;
                  end
```

```
                        end
                    end
                end
            end
        end
    end
  end
 end
end % finish the surrounding pixel-finding procedure
for dp=0:dpm % begin to store the pixel number at different critic radius into a stream named "Re"
 for i=a1:a2
  for j=b1:b2
    for k=c1:c2
      if C1(i,j,k)==dp+1
        Re(dp+1)=Re(dp+1)+1;
      end
    end
  end
 end
end % complete the procedure
RGB_label = label2rgb(C1(:,:,10),'jet'); % paint pore area with different colors according to pore size
figure, imshow(RGB_label) % show the colored pore configuration
```