# DEMO_0001_TPMS_Gradient_Samples

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This is a demo for:

- Building geometry for


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```
clear; close all; clc;
```

Plot settings

```
cMap=parula(250);
faceAlpha1=1;
faceAlpha2=0.5;
edgeColor1='none';
edgeColor2='none';
fontSize=15;
```

# Example 1: A closed Sheet-Network surface

Creating control parameters depending on the type of demo the user wants to run

```
testCase = 2;
switch testCase
    case 1 % PAPER, figure 1
        inputStruct.L=[3 1 1]; % characteristic length
        inputStruct.Ns=200; % number of sampling points
        inputStruct.surfaceCase='g'; %Surface type
        inputStruct.numPeriods=[6 2 2]; %Number of periods in each direction
 [6 2 2]
    case 2 %
        inputStruct.L=[3 1 1]; % characteristic length
        inputStruct.Ns=50; % number of sampling points
        inputStruct.surfaceCase='g'; %Surface type
```

```
        inputStruct.numPeriods=[6 2 2]; %Number of periods in each direction
 [6 2 2]
end

levelset= 1; %Isosurface level (0 for cellSize)
gradType= 'cellSize'; % choose between cellSize or levelSet
```

# Create triply periodic minimal surface

```
%Get parameters from input structure
L = inputStruct.L; % characteristic length
Ns = inputStruct.Ns; % number of sampling points
k = inputStruct.numPeriods;

%Create coordinates
xMin=0; xMax= 2*pi*k(1,1);
yMin=0; yMax= 2*pi*k(1,2);
zMin=0; zMax= 2*pi*k(1,3);

xRange=linspace(xMin,xMax,Ns);
yRange=linspace(yMin,yMax,Ns);
zRange=linspace(zMin,zMax,Ns);
[X,Y,Z]=meshgrid(xRange,yRange,zRange);

switch gradType

    case 'cellSize'
        % Calculate gradient frequency
        m=3;
        K1= (m-1)/(xMax-xMin);
        C1= (xMin*K1)+1;
        C0= 0.5*K1*(xMin)^2;

        a = K1/2*X+C1+C0/X;
        b = K1*X+C1;
        c = K1*X+C1;

        %Calculate 3D image data

 S=(sin(a.*(X-1/4*pi)).*cos(b.*(Y-1/4*pi)))+(sin(b.*(Y-1/4*pi)).*cos(c.*(Z-1/4*pi)))+(cos(
        S=reshape(S,size(X));

    case 'levelSet'

        %Calculate 3D image data
        S=(sin(X).*cos(Y))+(sin(Y).*cos(Z))+(cos(X).*sin(Z));
        S=reshape(S,size(X));

        % levelset gradient
        GF=X; % Use x-dir for now
        GF=GF-min(GF(:)); % 0-...
        GF=GF./max(GF(:)); % 0-1
```

```
        GF=GF*((1/0.3)-(1/1.2)); % 0-2.5
        GF=GF + (1/1.2); % 0.8333-3.3333

        S=S.*GF;

%         sv3(S); colormap warmcold;
%         caxis([0 1.2])

end
```

# Scaling coordinates

```
switch length(L)
    case 1
        X=((X./abs(xMax-xMin)).*L);
        Y=((Y./abs(yMax-yMin)).*L);
        Z=((Z./abs(zMax-zMin)).*L);

    case 3
        X=((X./max(X(:))).*L(1,1));
        Y=((Y./max(Y(:))).*L(1,2));
        Z=((Z./max(Z(:))).*L(1,3));
end
```

# isosurface

```
[F,V] = isosurface(X,Y,Z,S,levelset);
C=zeros(size(F,1),1);

[fc,vc]=isocaps(X,Y,Z,S,levelset, 'above');
nc=patchNormal(fc,vc);
cc=zeros(size(fc,1),1);
cc(nc(:,1)<-0.5)=1;
cc(nc(:,1)>0.5)=2;
cc(nc(:,2)<-0.5)=3;
cc(nc(:,2)>0.5)=4;
cc(nc(:,3)<-0.5)=5;
cc(nc(:,3)>0.5)=6;

%Join sets
[f,v,c]=joinElementSets({F,fc},{V,vc},{C,cc});
[f,v]=mergeVertices(f,v); %Merge nodes

%Check for unique faces
[~,indUni,~]=unique(sort(f,2),'rows');
f=f(indUni,:); %Keep unique faces
c=c(indUni);

%Remove collapsed faces
[f,logicKeep]=patchRemoveCollapsed(f);
c=c(logicKeep);
```

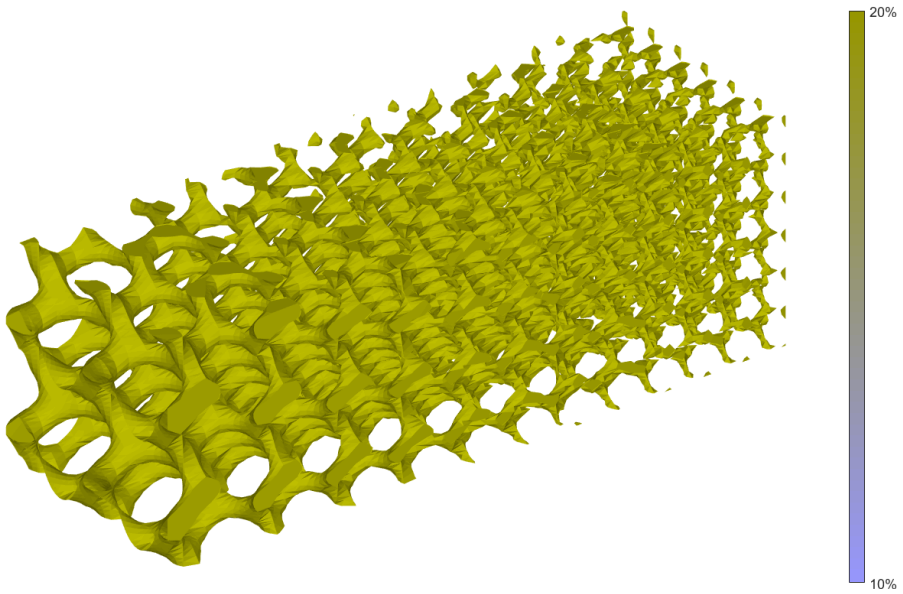
```
%Remove unused points
[f,v]=patchCleanUnused(f,v);

f=fliplr(f); %Invert faces
```

# gradient color

```
[Vm] = patchCentre(f,v);
```

# Visualize surface

```
cFigure; hold on;
% gpatch(f,v,Vm(:,1),'none', 1);
gpatch(f,v,[0.75, 0.75, 0],'none', 1);
axis off;
axisGeom; camlight headlight;

map=[0.6*ones(256,2), linspace(1, 0, 256)'];

% reduced sampling
x0 = [0 0.008889 0.03556 0.08 0.1422 0.2222 0.32 0.4356 0.5644 0.68 0.7778
 0.8578 0.92 0.9644 0.9911 1];
CT0 = [0 0 0.1; 0.002914 0.01103 0.1143; 0.01221 0.02996 0.1352; 0.02938
 0.04745 0.1489; 0.05622 0.07057 0.1604; ...
    0.09753 0.1003 0.1803; 0.1756 0.1568 0.2046; 0.2908 0.2456 0.2395; 0.4299
 0.355 0.2906; 0.5757 0.4753 0.3516; ...
    0.7288 0.6116 0.427; 0.8555 0.7448 0.5124; 0.9486 0.8541 0.6076; 0.9871
 0.9329 0.7081; 0.9983 0.983 0.809; 1 1 0.95];

CT0 = flipud(CT0);

% generate a new uniform table of desired length
N = 256;
xf = linspace(0,1,N);
CT = interp1(x0,CT0,xf,'pchip');

cmap = colormap(map) ; %Create Colormap
cbh = colorbar;  %Create Colorbar
cbh.Ticks = linspace(0, 3, 4); %Create 4 ticks 10%-40%
cbh.TickLabelInterpreter = 'tex';
cbh.TickLabels = {'10%','20%','30%','40%'} ;    %Replace the labels of these 8
 ticks with the numbers 1 to 8
gdrawnow;
```




# calculate volume fraction

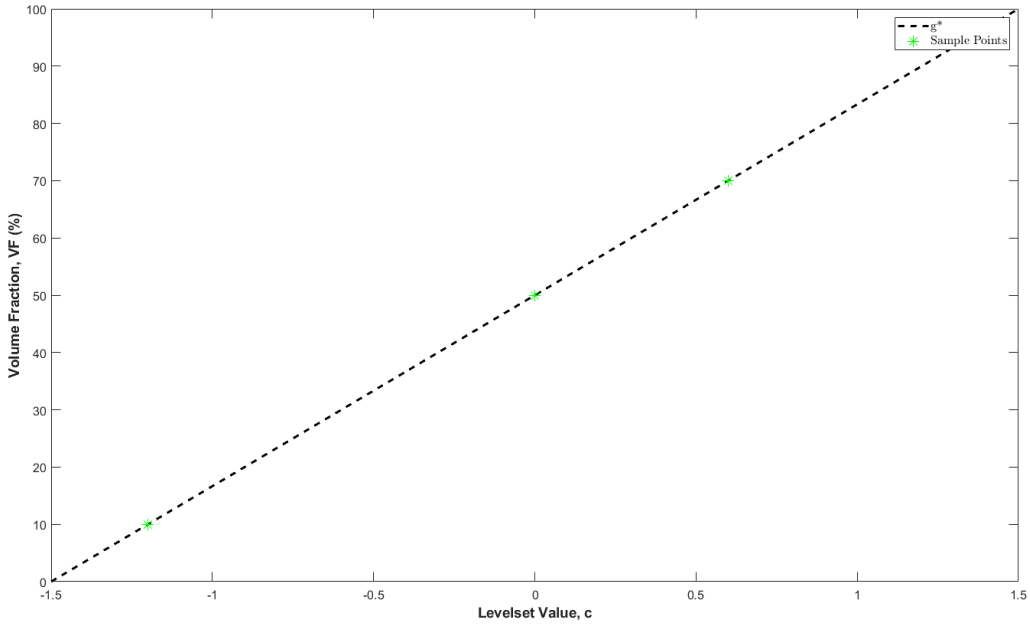
```
volSurf=patchVolume(f,v,0) % solid volume
VolTotal= L(1,1)*L(1,2)*L(1,3) % total volume
VF=volSurf/VolTotal % volume fraction
```

```
volSurf =

    0.3148


VolTotal =

     3


VF =

    0.1049
```

# Plotting gyroid VF vs levelset

```
a = 1/3;
b = 0.5;

x = linspace(-1.5, 1.5, 101);
y = (a*x + b)*100;
```

```
% c=[-0.6, 0, 1.2];
% VF=[10, 50, 70];
% V(1,:)= c;
% V(2,:)= VF;

cFigure;
plot (x, y, 'k--', 'LineWidth',2.2);
hold on;
plot(x(11),y(11),'g*', 'MarkerSize',11);
plot(x(51),y(51),'g*', 'MarkerSize',11);
plot(x(71),y(71),'g*', 'MarkerSize',11);

ax = gca;
ax.FontSize = 12;
yticks= linspace (0, 100, 11);

xlabel('Levelset Value, c', 'FontSize',14,
  'FontWeight','bold', 'FontSmoothing','on');
ylabel('Volume Fraction, VF (%)', 'FontSize',14,
  'FontWeight','bold', 'FontSmoothing','on');

set(legend,'FontSize',12);
legend( 'k--', 'VF = 1/3 c + 1/2 ' , 'Interpreter','latex')
legend('g*', 'Sample Points')
% set(legend,'Interpreter','latex');
```

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