Contents

Monte-Carlo Modeling of Electron Transport

Assignment 1 - Joanna Abalos 100962263

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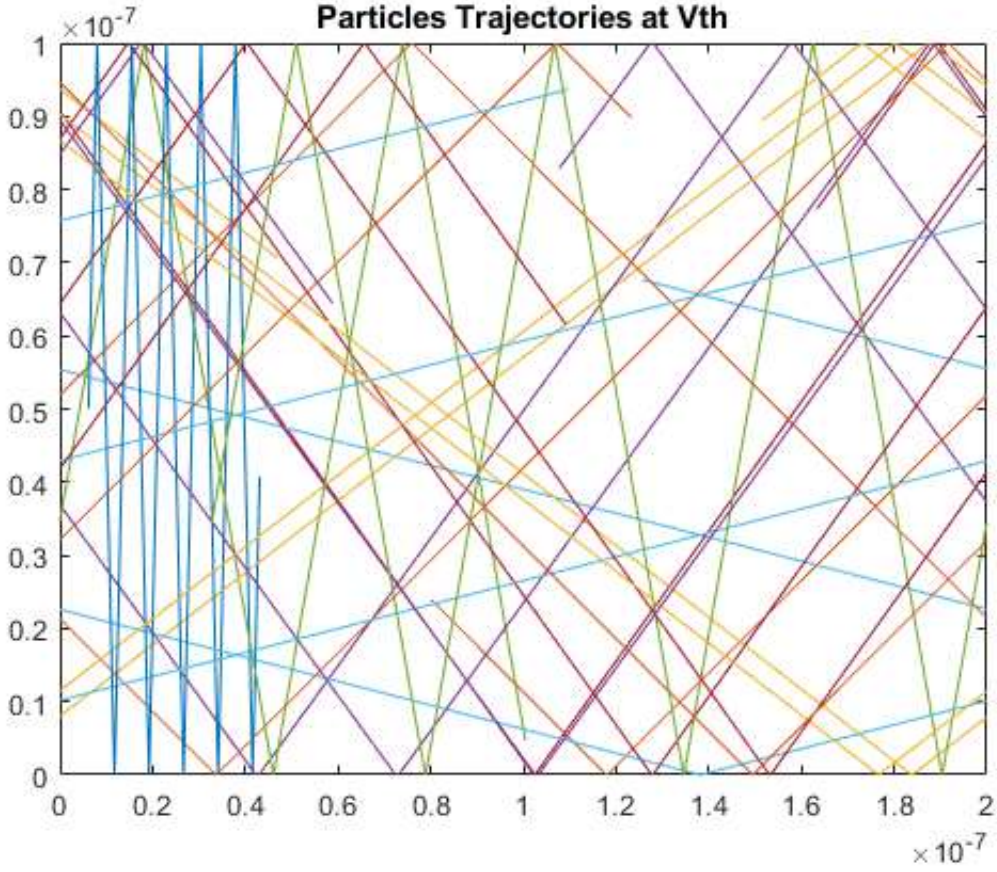
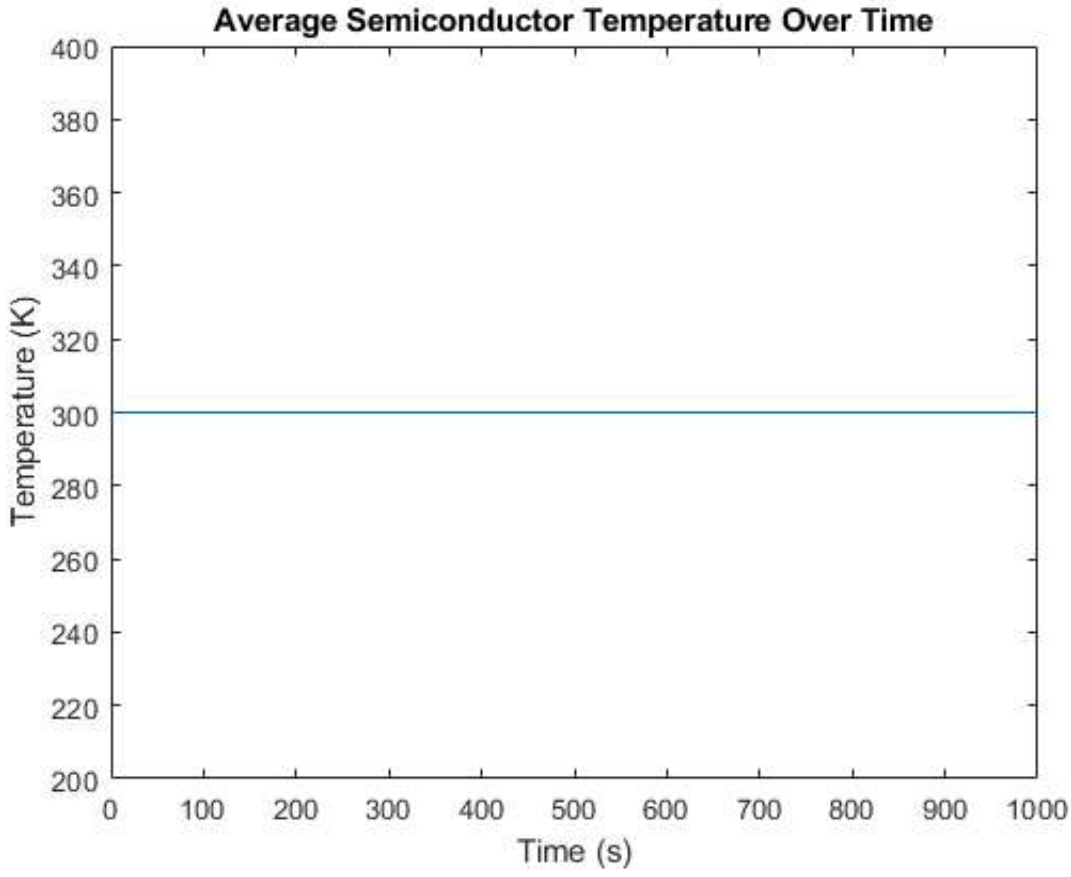
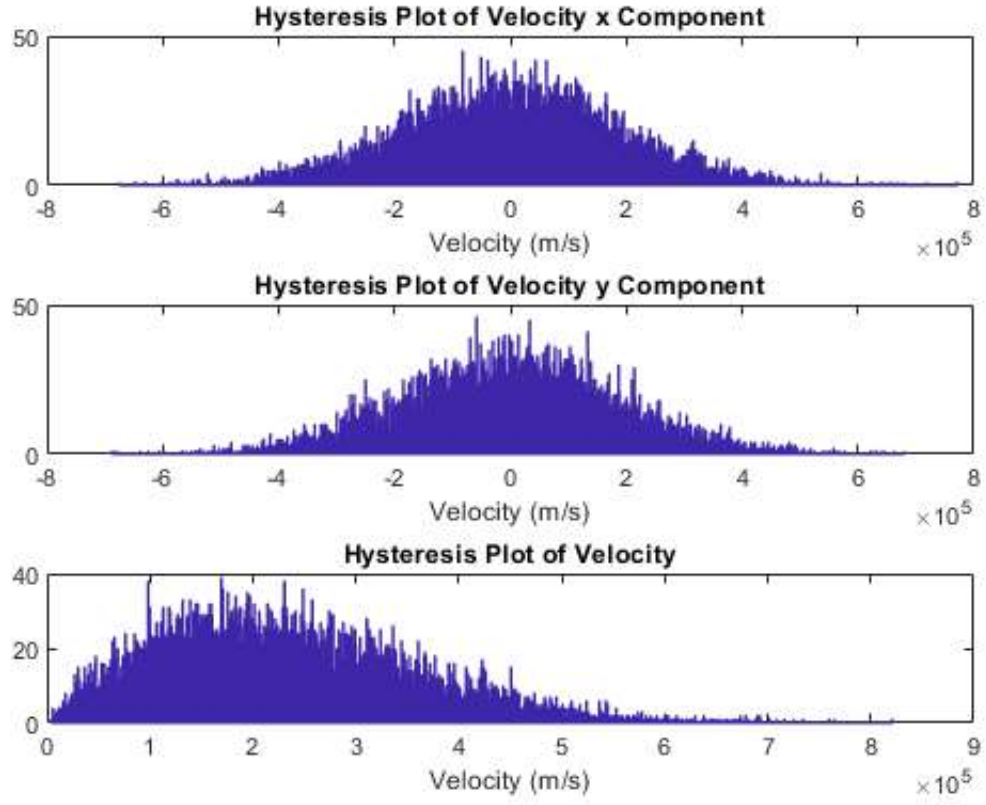
Assignment1_1
Assignment1_2
Assignment1_3

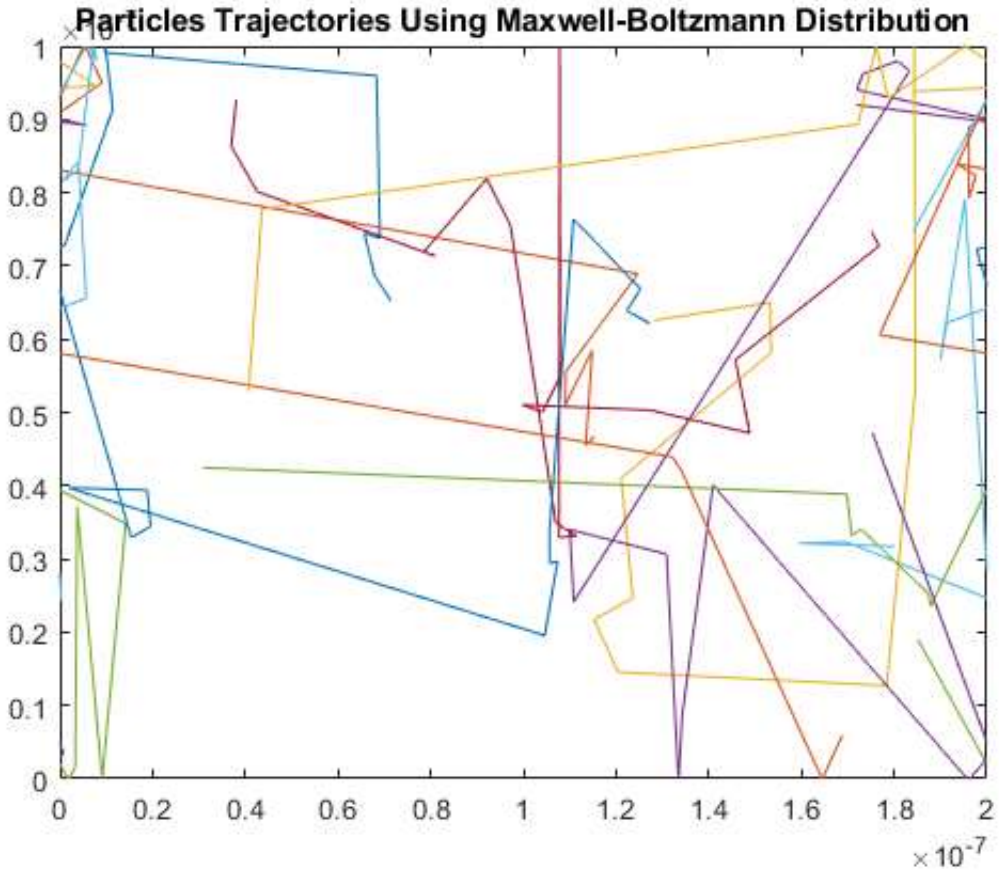
% In this assignment, 10 000 particles are modelled to calculate
% temperatures, make models and observations using Monte-Carlo modeling. 7
% particles are plotted to observe their trajectories.
```

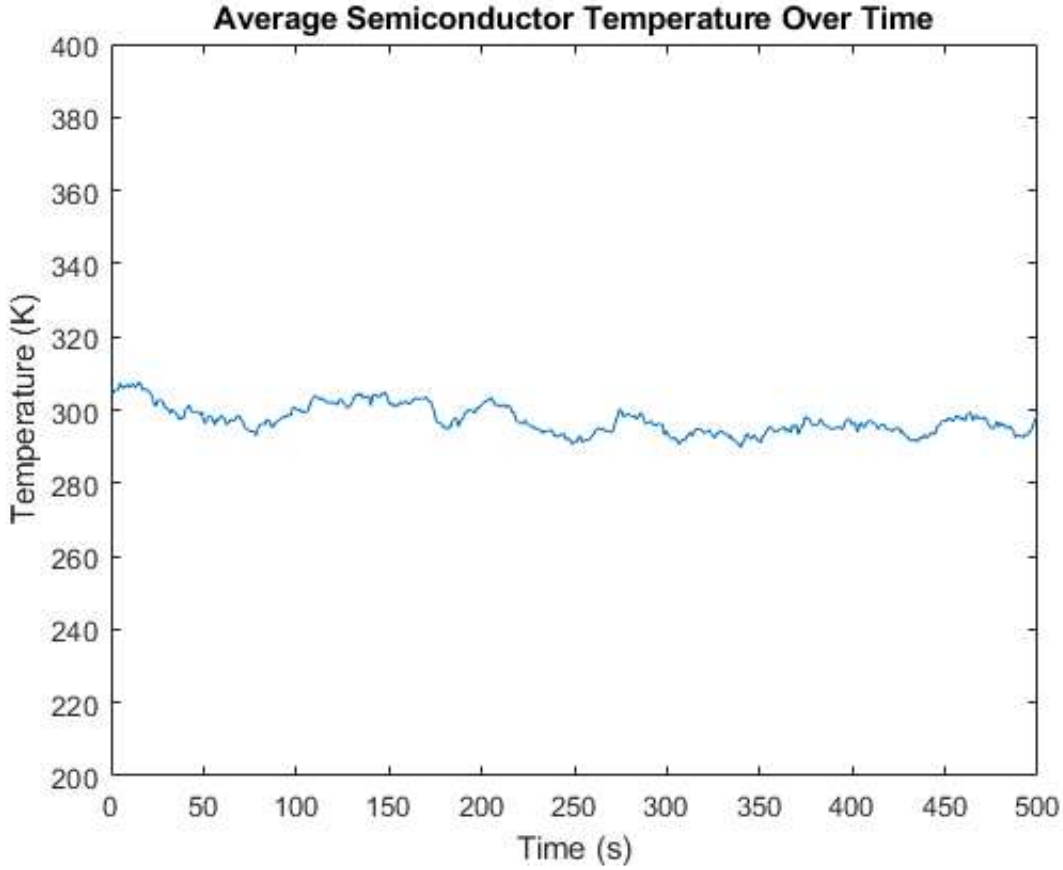
```
Part 1:
The thermal velocity is 1.870193e+05 m/s.
The Mean Free Path is 3.740385e-08 m.
Part 2:
The Mean free path is 3.060140e-08 m/s.
The Mean Time Between Collisions is 1.925305e-13 m.
```

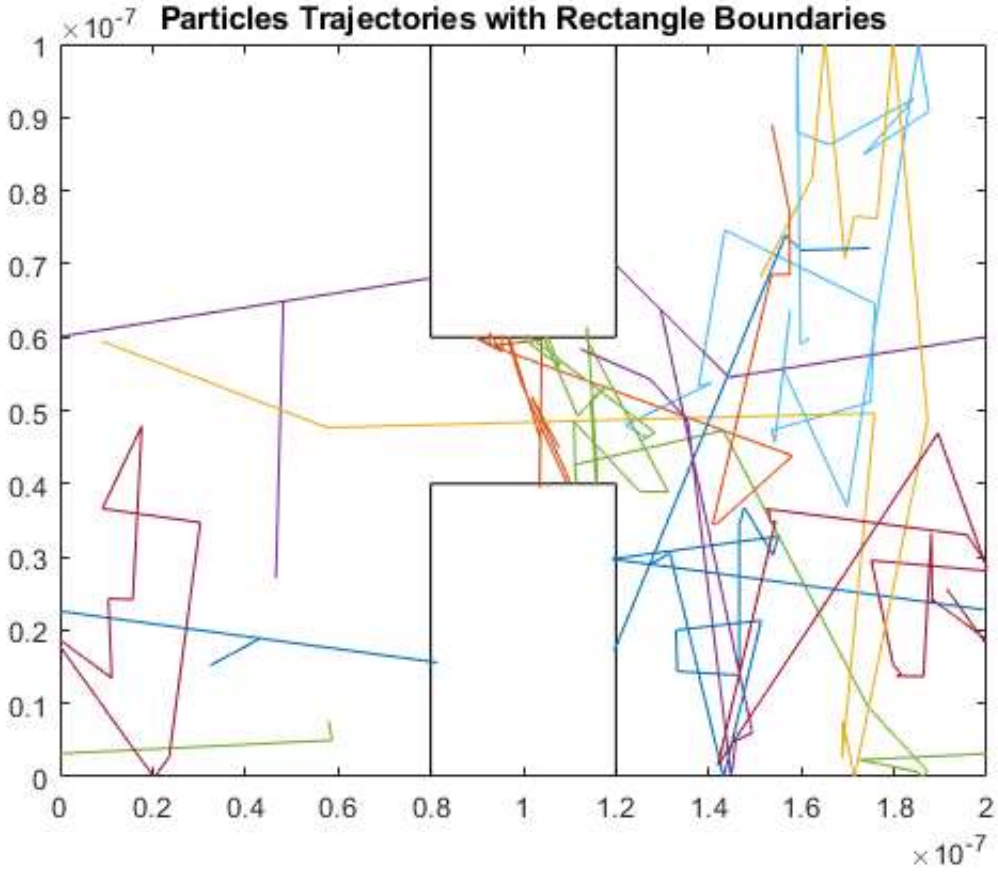

Particles Trajectories at Vth
×10^-7
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
×10^-7

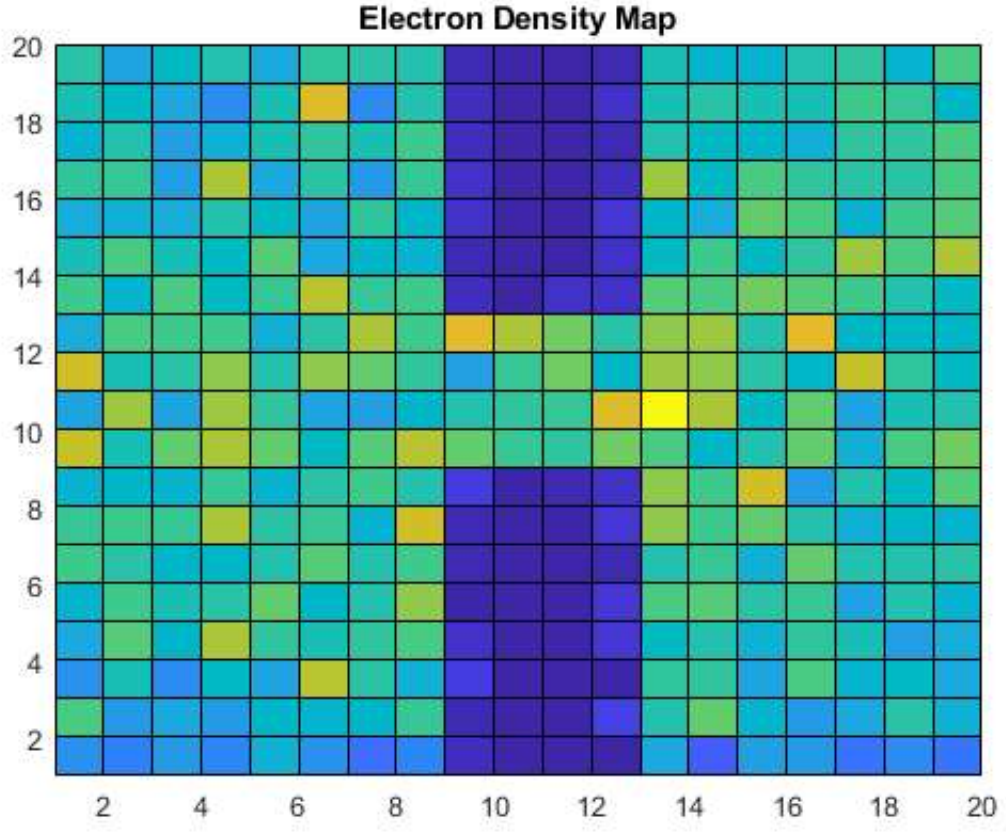

Average Semiconductor Temperature Over Time
Temperature (K)
400
380
360
340
320
300
280
260
240
220
200
0
100
200
300
400
500
600
700
800
900
1000
Time (s)

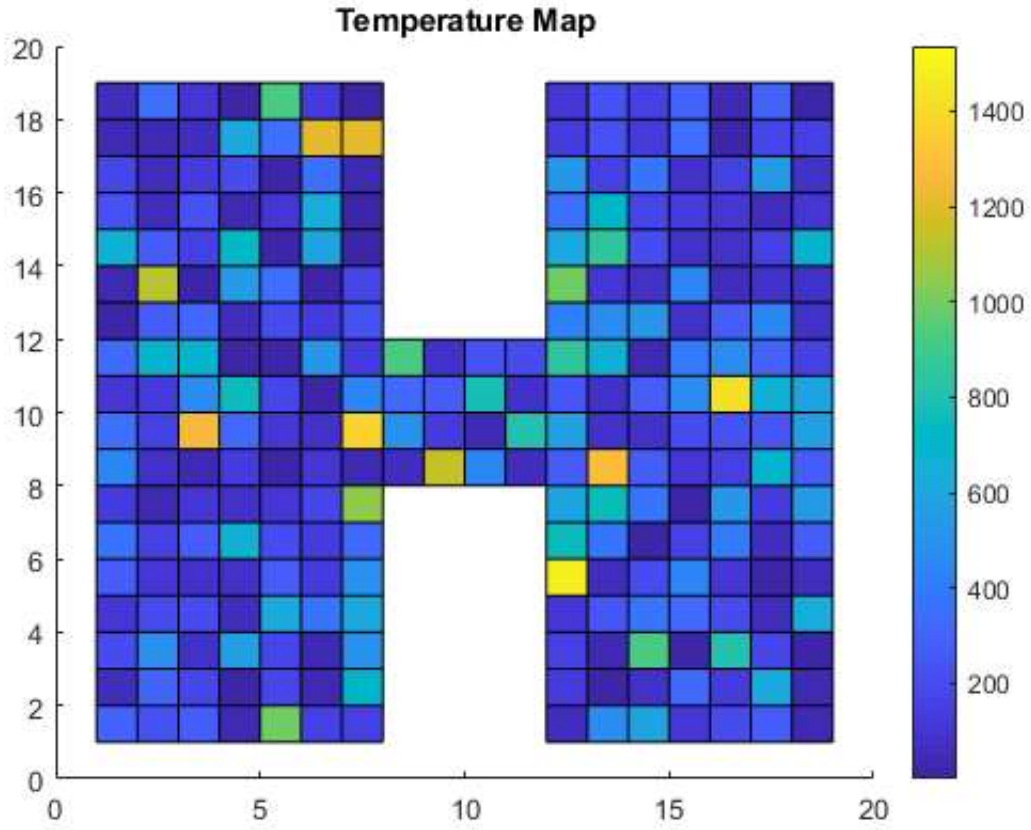

Hysteresis Plot of Velocity x Component
Velocity (m/s)
×10^5
Hysteresis Plot of Velocity y Component
Velocity (m/s)
×10^5
Hysteresis Plot of Velocity
Velocity (m/s)
×10^5


Particles Trajectories Using Maxwell-Boltzmann Distribution
×10^-7


Average Semiconductor Temperature Over Time
Temperature (K)
Time (s)
400
380
360
340
320
300
280
260
240
220
200
0
50
100
150
200
250
300
350
400
450
500


Particles Trajectories with Rectangle Boundaries
×10^-7
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
×10^-7





1 Electron Modelling

```
% Figure 1 displays a subset of the particle trajectories travelling at the
% thermal velocity. The particles that reach the top and bottom boundary
% have their velocities reversed.

% Figure 2 shows that the semiconductor temperature remains constant since
% all particles are travelling at the same velocity.
```

2 Collisions with Mean Free Path (MFP)

```
% Figure 3 displays the hystersis plots of the particle velocities. The X
% and Y components of velocity are a normal distribution scaled by the
% thermal velocity (Vth). The resulting overall velocity of each particle
% results in a Maxwell-Boltzmann distribution.

% Figure 4 displays a subset of the particle trajectories travelling at the
% velocities defined by the Maxwell-Boltzmann distribution. After
% calculating the probability of scattering and applying them to each
% particle, the scattered particles are assigned new velocities as defined
% by the Maxwell-Boltzmann distribution.

% Figure 5 shows that the average semiconductor temperature over time
% averages at around 300K. This is because the particles are travelling at
% an average velocity of Vth.
```

3 Enhancements

```
% Figure 6 displays a subset of the particle trajectories that scatter
% similar to Figure 4 except with rectangle boundaries at which the
% particles bounce.

% The Electron Density Map in Figure 7 shows that the particles are not
% present within the boxes. It appears that a few particles did penetrate
% the edges slightly but box region should have no particle penetration.

% The Temperature Map in Figure 7 shows that the average overall
% temperature of the region is around 300K. There is no temperature
% calculated in the areas where there are no moving particles (within the
% boxes).
```

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