

# [Optical absorption of a gallium arsenide semiconductor](https://assignbuster.com/optical-absorption-of-a-gallium-arsenide-semiconductor/)

Abstract

In this report, an investigation into the light absorption of a direct band gap semiconductor, GaAs is recorded. By subjecting the GaAs semiconductor to a range of infra-red wavelengths and then comparing the light transmission through the semiconductor to the light transmission when no semiconductor was present, the following experimental values were obtained: the characteristic photoreflectance; the characteristic band gap energy; and the characteristic absorption edge width. The first of these was obtained by the analysis of data when the semiconductor was transparent, and the two energy values by analysis of the Urbach tail region for said GaAs semiconductor. The absorption coefficient as a function of wavelength will also be determined. This general area of research facilitates the use of complex circuitry to make possible the creation, and thus application, of copious electrical equipment, from digital watches to racing cars and beyond.

1. Introduction and theory

Somewhat disputedly, the effects of what are now known as semiconductors appear to have been first noted by physicist Thomas Johann Seebeck in 1821 [1] . However, the first record of the significant consequence of these materials’ existence is often attributed to Michael Faraday for his 1833 account of how a compound of silver sulphide decreases in resistance when heated, contrary to other metals previously tested [2] . Similarly, in 1873, Willoughby Smith noted the decreasing of resistance of selenium rods in the presence of strong light [3] . The understanding of the theory of semiconductors made great progress after JJ Thomson’s discovery of the electron in 1897 [4] , when electron-based conduction was proposed, enabling a much better understanding of these semiconductors. A while later, shortly following Bernhard von Gudden’s 1930 theory that semiconductor conductivity came from small concentrations of impurities, the theory of band gaps was formulated by Alan Herries Wilson, thus confirming Gudden’s finding [5] . The ensuing advancements in both solid state and quantum physics led to a much more fundamental understanding of semiconductors and was instrumental in the development the physics used in this investigation.

A semiconductor is defined as a substance that is capable of conducting electricity, but only under certain conditions (prescribed by the material properties of said substance), which renders a semiconductor effective in its primary use of controlling electrical current levels. [6] Semiconductor theory relies on a combination of the aforementioned disciplines of solid state and quantum physics which when combined and applied, give band theory. Band theory states that, in semiconductors, electrons’ energy levels are sufficiently close to each other as to form so-called ‘ energy bands’, each formed of many energy levels, all very close to each other [7] . Consider three varieties of substance, namely insulators, conductors and semiconductors. In conductors, such as most metals, the energy band gap, 'Position',[100 70 70 40],'Callback',@wavelength);

Wavelength\_up = uicontrol('Style','pushbutton','String','Up',...

'Position',[100 120 70 40],'Callback',@go\_up);

Wavelength\_down = uicontrol('Style','pushbutton','String','Down',...

'Position',[100 20 70 40],'Callback',@go\_down);

s. Rate = 1000

s. NumberOfScans= 500;

nout = [51 102 204 153]; % decimal sequence for forward motion

% This is the callback function for the toggle button.

% It alters the wavelength when the toggle button is pressed.

% 'hObject' is the handle for the uicontrol calling the function.

function wavelength(hObject, eventdata)

b = 1;

while hObject. Value == hObject. Max

for m= 1: 3

for n= 1: 4

input\_data= dec2binvec(nout(n), 8);

% high state= 1 low state= 0

outputSingleScan(s1, input\_data);

% outputs the data in output\_data to the device

pause(0. 3)

end

end

[data, timestamps] = startForeground(s);

V(b) = (mean(data(:, 1)));

f(b)=(5/3)\*b+(800-(5/3))

b = b+ 1;

plot(f, V,'xb-');

end

figure

dlmwrite('E: ProjectdataV. txt', V);

dlmwrite('E: Projectdataf. txt', f);

end

% These are the callbacks for the pushbuttons.

% They set the direction of travel for the motors.

function go\_up(hObject, eventdata)

nout = [51 102 204 153];

end

function go\_down(hObject, eventdata)

nout = [153 204 102 51];

end

end