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Study of fluctuations and simulation of layered solar cells

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Abstract. To observe the chaotic behavior of solar cell a number of Si solar cells were selected. For this chaotic behavior, a circuit similar to the solar cell circuit was used The absorption spectrum was not same at every point of solar cell. The value randomly increased and decreased. Thus chaotic behavior also present in absorption spectrum. Solar cell is a nonlinear device. So some level of chaos is always present, and it cannot be ignored. For better performance efficiency and absorption spectrum of solar cell should be increased. The absorption coefficient was different at different cell point and it varies randomly.In the range of wavelength 365 nm to 600 nm, solar cell possesses maximum absorption, which is the visible range of electromagnetic spectrum. The value of absorption coefficient at this range was 4. The absorption coefficient was suddenly decreased to a value '0' at approximately 360 nm wavelength. The value also decreased when the wavelength increased from 600 nm wavelength.

Keywords: Chaotic, solar cell, absorption.

1 Introduction

Chaos, or exponential sensitivity to small perturbations, appears everywhere in nature. Moreover, chaos is predicted to play diverse functional roles in living systems.[1] For a chaotic system pairs of initially close-by trajectories become eventually fully uncorrelated on the attracting set. This process of decorrelation can split into an initial exponential decrease and a subsequent diffusive process on the chaotic attractor causing the final loss of predictability. Both processes can

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be either of the same or of very different time scales [2]. Minority carrier transport parameters critically affect operation and performance of many p-n junction semiconductor devices including bipolar transistors and solar cells. For solar cells in particular, both open circuit voltage (V_{oc}) and photogenerated current density (J_L) depend on minority carrier mobility and effective carrier lifetime in the absorber material [3]. Chaos means a random unpredictable and disorderly behavior but have an intrinsic feature of determinism and characteristic of order. Many models used in solid-state physics consist of coupled or driven nonlinear oscillators whose time evolution must show chaotic behavior within a suitable parameter range. On the other hand, competition of various commensurable or incommensurable periods makes chaos an intrinsic source for spatial disorder. [4,5].

2 OBSERVATION

To observe the chaotic behavior of solar cell a number of Si solar cells were selected. For these chaotic behavior an oscillator circuit was used, which is shown in figure 1. The circuit was connected with a sine generator. Various phenomena, which appear in the transition range between periodic and chaotic oscillations, were examined as a function of the generator voltage.

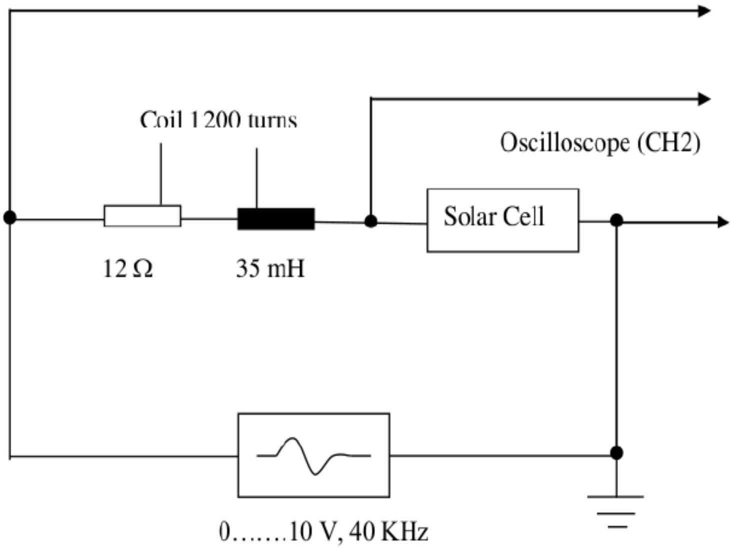

Figure 1: Experiment circuiting setup.

Circuit was stimulated to forced oscillation. The oscillations and the corresponding Fourier spectrum as a function of the supplied alternating voltage were examined. The voltage ranges in which chaotic oscillations appear were determined. The applied voltage was gradually increased from low values up to the maximum value. For the recorded measurements and as a function of the applied voltage and graphically plot the fundamental frequency appearing in the Fourier spectrum and if present and the multiple up to the quadruple of the fundamental frequency. The circuit at first driven at 1.8 volt. The corresponding Fourier spectrum was observed with help of software “Phywe Measure 4”. This shows that practically only the fundamental frequency is present. The amplitude of spectra was .049 volt.

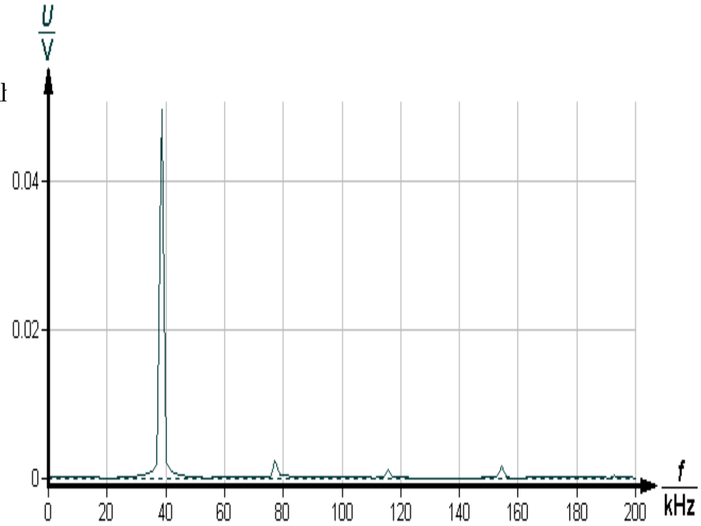

Figure 2: Fourier spectrum of 0.1 Volt

The signal was now changed to 0.8 V and an intensive oscillation appeared on the corresponding Fourier spectrum. This was illustrated in figure 3.

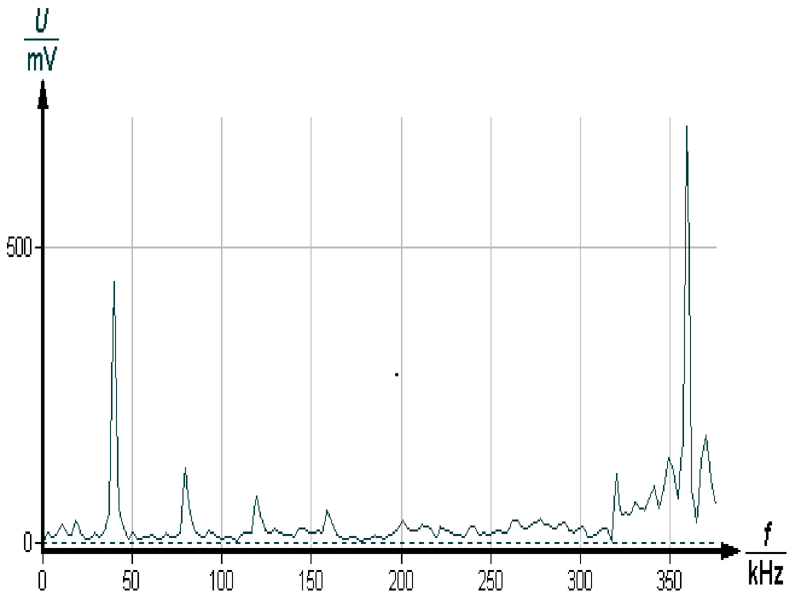

Figure 3: Fourier spectrum of 0.8 Volt

When the signal was changed to an increased voltage 1 V, and intensive first and second harmonic oscillation appeared in the corresponding Fourier spectrum. This was illustrated in Figure 4.

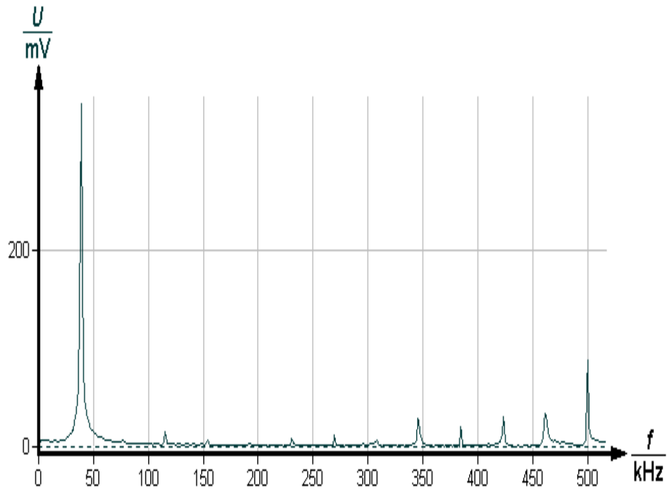

Figure 4: Fourier spectrum of 1.0 Volt

Another periodic doubling appeared at 2.0 V, before the oscillation behavior begun to show signs of a beginning chaotic behavior on the oscilloscope. The basic structure of a periodic oscillation spectrum with a fundamental frequency of 25 KHz interfaced with noise, which in itself yield a certain structurization. The signal was not periodic, instead the intervals and amplitudes of the individual oscillation change without any recognizable consistency.

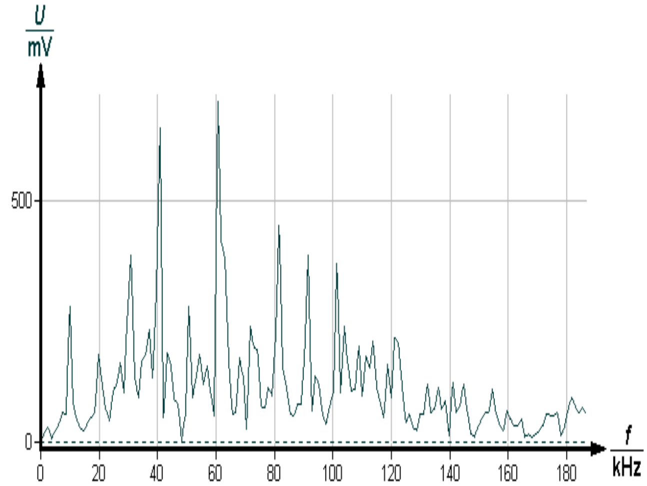

Figure 5: Fourier spectrum of 2.0 Volt.

When the voltage applied to circuit with 8.0 V the mode of oscillation was changed to chaotic form as in Figure 6. A large number of spectra were observed from the corresponding Fourier spectrum. From these voltage chaotic behavior continued according to the further increase of voltage

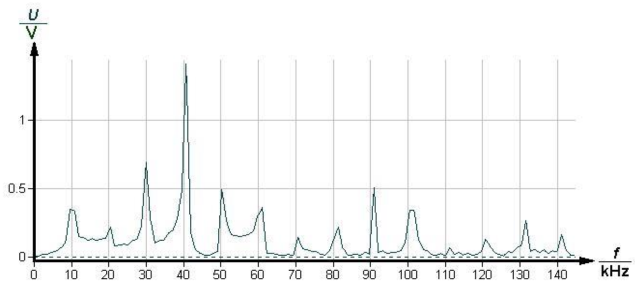

Figure 6: Fourier spectrum of 8.0 Volt.

3 ANALYSIS OF CHAOS IN SOLAR CELL

A Si solar cell was analyzed by spectrophotometer. The absorption coefficient was different at different cell point and it varies randomly. In the range of wavelength 365 nm to 600 nm, solar cell possesses maximum absorption, which is the visible range of electromagnetic spectrum. The value of absorption coefficient at this range was 4. The absorption coefficient was suddenly decreased to a value '0' at approximately 360 nm wavelength. The value also decreased when the wavelength increased from 600 nm wavelength. From 600 to 1100 nm wavelength the absorption coefficient varies from 2.8 to 3.2. The corresponding absorption spectrum is shown in figure 7.

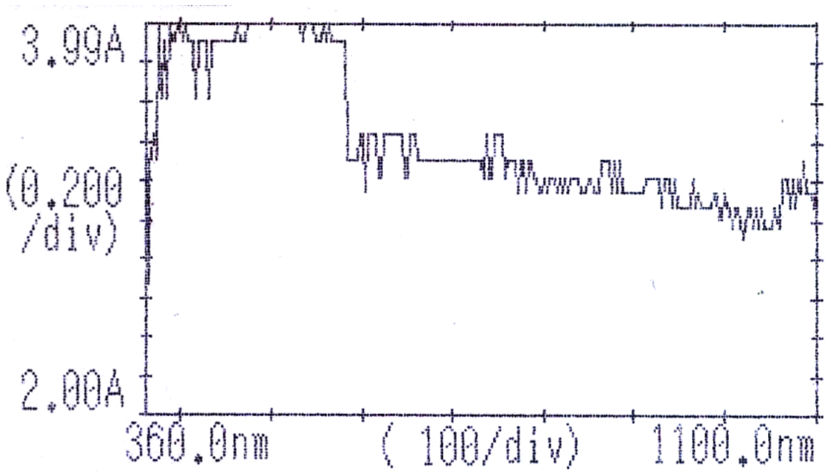

Figure 7: Absorption spectrum of solar cell

4 CONCLUSIONS

For setting up the experiment all the procedure and instructions were followed properly and reasonably perfectly step by step. The circuit used in this work was the simplest oscillator circuit. However this simple circuit was taken just to study the nonlinear behavior. At the low applied voltage, the oscillator showed almost harmonic behavior.

At that time, the nonlinear solar cell was not apparent through the distortion of the sine signal. When the applied voltage was increased, the oscillator changed its behavior. The subharmonic started to appear in the corresponding Fourier spectrum. When the source voltage applied to the circuit was increased to a further value, a characteristic deformation was appeared. When the voltage reached a certain value a series of abnormalities was observed, the oscillator exhibit fully chaotic mode. The absorption spectrum was not same at every point of solar cell. The value randomly increased and decreased. Thus chaotic behavior also present in absorption spectrum. Solar cell is a nonlinear device. So some level of chaos is always present, and it cannot be ignored. For better performance efficiency and absorption spectrum of solar cell should be increased. Chaotic behavior of silicon solar cells has been observed in various environmental conditions. Random, irregular, aperiodic and unpredictable behaviors have been identified and recorded. Spectrum of the silicon solar cells in the region 360 nm to 1100 nm has been recorded using spectrophotometer. It has been found that chaotic region is present in the absorption spectrum, which may be due to various defect, dislocation, and non-uniformity of the sample cells. The instability on exposure to light have been identified which could be explained in terms of symmetry modification of the lattice due to illumination. These chaotic phenomena can be effectively used to achieve high efficiency solar cells by eliminating chaos in the operating region of the cell using filtering system.

References

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