Characterization of Dust Materials on the Surface of Solar Panel

M. R. Maghami[1, 2], Hashim Hizam[1, 2], Chandima Gomes[1], Ismail. A.G[3]

[1]Department of Electrical and Electronic Engineering, Faculty of Engineering, Universiti Putra Malaysia, 43400 Serdang, Malaysia
[2]Centre of Advanced Power and Energy Research (CAPER), Universiti Putra Malaysia, 43400 Serdang, Malaysia
[3] Department of Environment, Faculty of Engineering, Universiti Putra Malaysia, Serdang 43400, Selangor, Malaysia
Mr.maghami@gmail.com

Abstract: Dust is particles that come from the environment such as soil and pollution. Dust has become one of the major issues with regards to the performance of a solar panel. One of the contributing factors on solar performance is accumulated dust on the surface of solar panel which comes from the pollution and industrial area. In this paper, we investigate the dust materials on the surface of a Fix Flat solar panel collected using chemical precipitation method. In order to identify the dust material, size, shape and weight, we used scan Electron Micron and Energy-Dispersive X-ray spectroscopy. The results from this research show that most of the dust, which was accumulated on the surface of the solar panel, are siliceous, alumina and cement which come from construction around the site of the solar panel. There is also an evident of soil that comes from the highway and a little bit of contaminants from bird droppings.

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1. Introduction

Dust consists of particles in the atmosphere [1-3]that comes from various sources such as soil, dust lifted by weather, volcanoes, and pollution. Dust in homes, offices, and other human environments contains small amounts of plant pollen, human eruptions and animal hairs, textile fibers, paper fibers, minerals from outdoor soil, human skin cells, burnt meteorite particles, and many other materials which may be found in the local environment**.** Dust in the Asia region has become[4, 5]a major concern. Recently, because of climate change and the escalating process of desertification, the problem has worsened dramatically. As a multi-factor phenomenon, there is not yet a clear consensus on the sources or potential solutions to the problem.

In Malaysia, dust[6] is already affecting more than 1 million people directly due to haze condition usually happen during June and July which has emerged as a serious government issue in recent years. In the province of Serdang, it has led to the severe reduction of air quality. The amount of pollutants in the air has surpassed more than 15 times the normal level several times in a dry season. Recently, initiatives such as projects established directly on the Southeast Asia dust. Dust plays an important part on solar energy implementation.AS all of us know that, the cost for install solar performance is higher than other generation for this reason we need consider more about this issue. A few studies done about dust material on solar performance[7, 8] .The first work on the effect of dust on solar collectors was from Hottel and Woertz[9] in 1942, who investigated the effect of dust accumulation on solar performance .Their three month research was performed in industrial area and near track railroad which 90m faraway in Boston. Founding show that an average of 1% loss due to dust accumulating on the surface of solar plate. The maximum degradation reported during the research period was 4.7%. Soleimani et al in 2001[10]they studied about the effect of air pollution on photovoltaic performance. The influence of air pollution is quite considerable for a large city such as Tehran. The results from this study show that the Power output of photovoltaic solar panel reduce more than 60% due to air pollution.

MassiPavanin 2010[11],he was investigated the effect of dust and soiling. Two solar panels with tilting angle of 25 degree were under investigation. The data revealed that when the dust surface of the PV system covered with dust, in a sandy environment, the efficiency reduces by 6.9%, and in the location where the ground is more compact, the efficiency reduces by 1.1%, which indicates solar panel is more efficient on compact ground. A few research study done about dust material on solar panel taught most of them consider the effect of dust on efficiency or power output, but in this paper, we are planning to collect dust with chemical precipitation method from the surface of Fix flat photo voltaic panel, which accumulated during last two years from installation (2011). The purpose of this

analysis was to determine the type of elements, size and weight dust material.

2. Material and methods

2.1. Solar panel description

In this research, there are two Fix flat photovoltaic solar panels installed in Serdang, University Putra Malaysia. As you can see in Figure1, Fix flat photovoltaic panel, which made with mono-crystalline silicon CSUN modules, shows their data sheet that reported in Table1. These PV modules are made of 108 mono-crystalline silicon (9pcs x 12pcs), 125 mm x 62.5 mm, in standard test condition (STC: IEE 61215 -1000 W/M, 25℃) which installed two years before.

Figure 1. Fix flat photovoltaic in UPM site.

2.2. Location

According to the figure2 that illustrated the location of the site, this site located in a tropical climate and there is the railroad that has 500 meters distance from the site. There is new construction (GSM) that very close to the site just 50 meters far from UPM site and two highways, which located just 300 meters far away with normal traffic. Another thing we can mention here is vegetation around the site. Most of these areas covered with tropical trees.

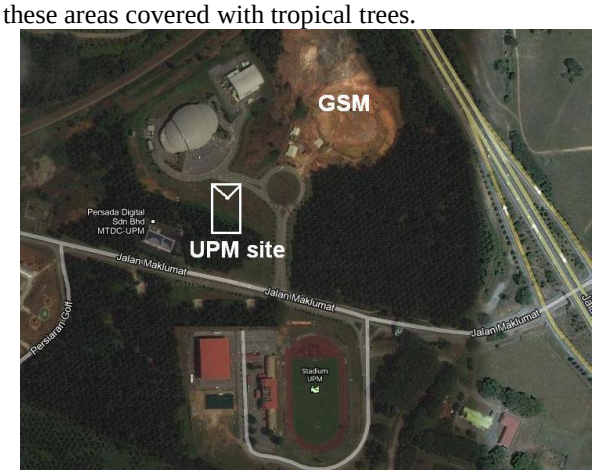

Figure 2. Location of Fix Flat photovoltaic

Table 1. Fix flat photovoltaic characteristics

Type	Appearance		
	Characteristics	**Pmax**	**Nominal**
1	Maximum power	95	92
2	Voltage	18.3	17.9
3	Current	5.21	5
4	Open circuit voltage	22.5	20
5	Short circuit current	5.56	5.4
6	Weight	8	8

2.3. Dust sample

Dust collects from the surface of solar panel every other week for 1 April 2013 until the end of December 2013.Dust sample sent to lab to recognize dust materials. In order to recognize dust materials we are using the Energy-dispersive X-ray spectroscopy and Scan Electron Micron (SEM). Energy-dispersive X-ray spectroscopy (EDX or XEDS) is an analytical technique used for the elemental analysis or chemical characterization of a sample. It relies on the investigation of an interaction of some source of X-ray excitation and a sample. Its characterization capabilities are due in large part to the fundamental principle that each element has a unique atomic structure allowing a unique set of peaks in its X-ray spectrum. A Scanning Electron Microscope (SEM) is a type of electron microscope that produces images of a sample by scanning it with a focused beam of electrons. The electrons interact with atoms in the sample, producing various signals that can detect is containing information about the sample's of surface topography and composition.

The sample prepared by the chemical precipitation method.The provided sample anchored on the sample and inserted in a Hitachi S 4300 N SEM. EDX Attached to the SEM in UPM Lab.

Working voltage of 15KeV used to analyze the residue. The analytical volume estimated approximately 1-micron deep and 1-micron across. Any sub-micron particles will contain signals from its surrounding materials. Approximately 70% of the stub area scanned for particles, avoiding the edges for unwanted particles due to handling.

3. Result and discussion

The SEM micrograph of dust particle showed in Figure 3. SEM gives accurate qualitative and quantitative determinations of the elemental composition of the dust mineral deposits.The image indicates the size of the sample particles in the range of 30–45 NM. More particles examined during scanning and representative set of particles captured.

These microanalyses reveal the predominance

of dust, with a K peak at 1.800 Kev and oxygen witha scale 1600 count (ka peak at 0.5 Kev), Aluminium with scale 1300 (ka peak at 1.5 Kev), silicon with scale 2500 (ka peak at 1.8 Kev). It also assumed that the minor elements such as fu, Ca, Ta, S and Au, which it is, show that in figure 3.

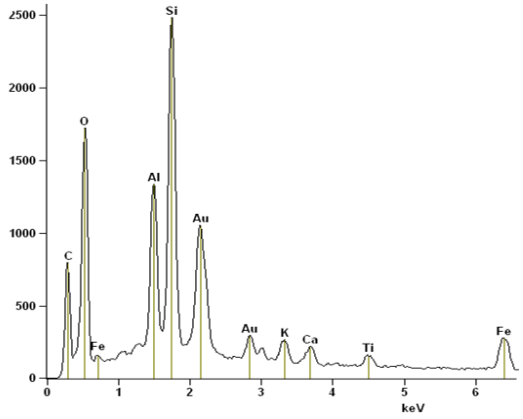

Figure3. SEM micrograph

Table 2, which illustrated the percentage of weight, Atom and Compound each element in this sample. From this result, it is clear most of them come from cement, which came from contractors for new buildings that very close to the site and an element like carbon come from the air, which accumulated, on the surface of the solar panel.

In addition, we find many elements, but the amount of this element, it is not a lot to consider. Figure 3,4 shows that the location of each element in the sample and type of material. In this case the volume median diameters of the dust particles are 2to 8μm. Dust with diameter more than 5μm come from construction and dust from pollution most of the less than 4μm.

Table 2. SEM weighs of the dust sample

Element	Weight%	Atom%	Compound%
C K	29.98	40.40	29.98
O K	48.12	48.68	48.12
Al K	4.85	2.91	4.85
Si K	9.76	5.62	9.76
Si L	---	---	---
K K	1.19	0.49	1.19
K L	---	---	---
Ca K	0.76	0.31	0.76
Ca L	---	---	---
Ti K	0.78	0.26	0.78
Ti L	---	---	---
Fe K	4.56	1.32	4.56
Fe L	---	---	---
Au L	---	---	---
Au M	---	---	---
Total	100.00	100.00	100.00

The dust from this result is a show that dust more acidic or alkaline. In the other word acidic dust could actually accumulate on the surface of glass cover are working with acid reaction. With the time pass from beginning the glass cover in force with small bumpy at the top of the panel this is equal reduce solar panel lifetime.

Bird dropping completely is acidic, as shown in the figure 5, some of them are acidic material.

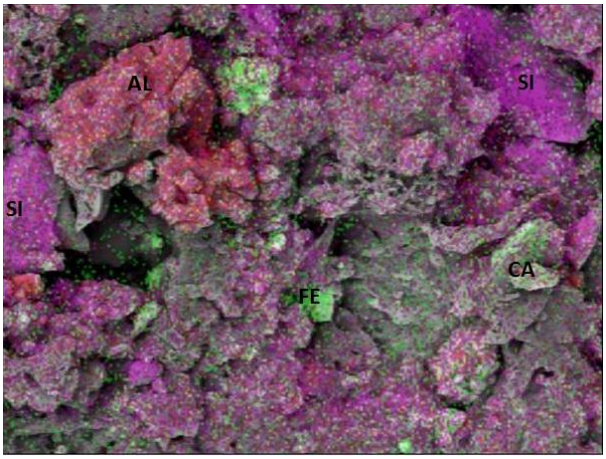

Figure4. EDX result

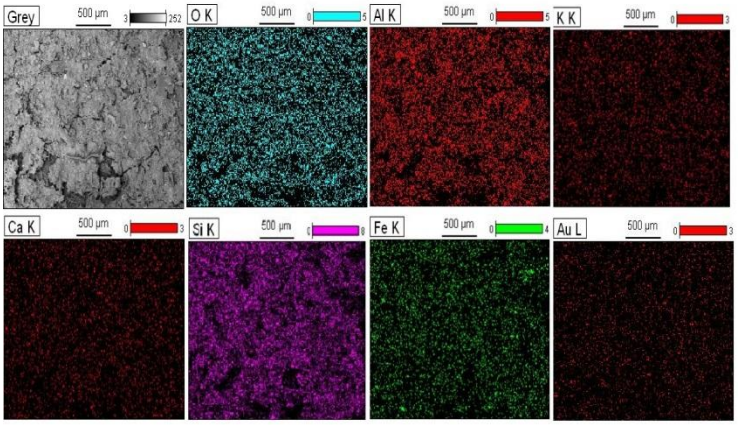

Figure5. Dust materials with EDX result

4. Conclusion

Several types of residue observed in the dust sample. Particles containing high signals off and silicon (Si) oxygen (O) and alumina (AL) mostly came from the contractor for a new building, which very closes, to the site. Particles containing carbon (C) together with the elements (O), chlorine (Cl), sodium (Na), potassium (K), and calcium (CA) were probably organic dust. Particles containing O, Al, Si, sulfur (S), calcium (CA) and, for some particles, additional anions, were

probably minerals (silicate, sulfate) or ceramics (alumina and silica). Therefore, study about environment on solar performance, especially location very important because if we can reduce loss from the environment on the system and on the other hand the efficiency of the system will improve. For further study I can recommend to improve the environment effect on solar energy is considered kind of glass which cover the surface of solar cells because the rate of absorb dust also related to the glass. In some regions like tropical climate, the most of the time dust will be acidic or alkaline for some reasons it is necessary to consider a different type of material under the surface of the solar cell.

5. Acknowledge

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