Abstract—In this study, laboratory measurement of dust removal efficiency of electrodynamic dust shield (EDS) prototypes was carried out using a real-world dust at mass loading levels relevant to solar energy applications. A removable dielectric cover method was employed to gravimetrically determine the dust removal efficiency. Three EDS prototypes with the same electrode configuration but different areas were used. The results suggest that scale-up does not negatively affect the EDS dust removal efficiency. However, the EDS dust removal efficiency decreased with decreasing dust loading, and it dropped significantly when the total dielectric cover thickness increased from 0.27 to 0.37 mm. Much of the persistent dust consisted of particles <20 μm, but these small particles constitute a large fraction of dust in the field. Depositing dust through a mesh sieve led to unnatural apparent size distribution, due to particle agglomeration. Future EDS studies need to use dust deposition methods that better simulate natural dust accumulation.

Index Terms—Dielectric cover thickness, dust loading level, dust removal, electrodynamic dust shield (EDS), particle agglomeration, performance loss, scale-up, soiling.

I. INTRODUCTION

As the interest in solar power generation in dusty environments is growing, soiling loss due to dust accumulation on solar surfaces is becoming a major concern [1]. Dependent on many factors, in a dusty environment, a photovoltaic (PV) module can accumulate 80–300 mg·m⁻² of dust per day, and every 100 mg·m⁻² of dust accumulation causes an additional output loss of 0.4–0.7% [2]. After being exposed to ambient dust for one month, the soiled PV module will typically be able to output 85% of the electricity it could if it was clean [3]. For large-scale solar PV power projects that are being developed in regions with high ambient dust concentrations, cleaning of the PV modules is needed for the improved economic return of solar power generation projects.

In recent years, electrodynamic dust shield (EDS) has been proposed as a candidate for antidust solutions for solar power generation [4], [5]. The technical concept of EDS was initially conceived for space applications, and is also known as electric curtain, electrodynamic screen, or electrostatic cleaning system [6]–[8]. Generally, the EDS consists of a substrate, electrodes, and a dielectric cover. The substrate is a flat insulating plate, on which the electrodes are attached or printed. The electrodes may be arranged into various patterns, with parallel straight-line patterns being the simplest. The dielectric cover is a thin layer of electrically insulating materials that isolate the electrodes from the atmosphere. The dielectric cover can be attached through an adhesive or be applied to the electrodes/substrate as a coating [4], [5]. When alternating high voltage is applied to the electrodes, it generates alternating electric field. The alternating electric field can repel dust from the air-side of the dielectric cover. Conceivably, we could have a standalone EDS cover the front surface of a PV module, or have the EDS functionality integrated into the PV module [9]. By energizing the EDS periodically, dust accumulated on the front side of the PV module will be repelled, and fall onto the ground or be blown away by wind. As long as the EDS does not cause exceedingly high loss in solar irradiation transmittance, it is possible that EDS could bring net economic benefits to solar PV by reducing dust accumulation on the PV surface. EDS could be designed to have traveling-wave [5] or standing-wave [4] alternating electric field. Comparing to the traveling-wave design, the standing-wave EDS design requires simpler electrical circuits and less complex high-voltage sources. The focus of this paper is the standing-wave design.

To develop EDS into an antidust solution for solar PV, there is a need to know its dust removal efficiency under conditions relevant to the application. Before we can carry out field studies, we should design our laboratory experiments that mimic the real-world conditions, using dust samples that are collected from the application environment. Previous studies have used high dust loading levels [4], [5], as shown in Table I. These dust loading levels are, in general, very high and are not necessarily relevant for terrestrial solar PV applications. For example, in the Middle East and North Africa region, dust accumulation rate on PV modules can be up to 300 mg·m⁻²·d⁻¹ [2]. Even at this high rate of dust accumulation, it would take 20 days to reach a dust loading of 6 g·m⁻², and 260 days for a dust loading of 78 g·m⁻². However, an operator may prefer to operate the EDS at much shorter intervals, e.g., daily or even hourly. Therefore,
TABLE I
EDS DIMENSIONS AND OPERATING CONDITIONS USED IN THE PREVIOUS STUDIES

<table>
<thead>
<tr>
<th>Study</th>
<th>Dimensions of EDS</th>
<th>Dust loading levels (g m⁻²)</th>
<th>Equivalent time of soiling under severe conditions (days)∗∗</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kawamoto and Shibata [4]</td>
<td>100 mm × 100 mm*</td>
<td>10–500</td>
<td>33–1667</td>
</tr>
<tr>
<td>Mazumder et al. [5]</td>
<td>150 mm × 150 mm</td>
<td>6–78</td>
<td>20–260</td>
</tr>
</tbody>
</table>

∗ A 560 mm × 320 mm EDS device was also used for demonstration, but no EDS efficiency was reported for that device.
∗∗ “Severe conditions” refer to a dust accumulation rate of 300 mg m⁻² d⁻¹.

it would be useful to know the dust removal efficiency at lower dust loading levels, so as to be able to assess the benefits of applying the EDS technology in PV solar power generation.

It is also important to study the EDS efficiency using dust that is relevant to solar PV applications. Various types of dust have been used in the previous studies, including sands from different locations and Martian dust simulants [4], [5], [10]. The particle size distribution and chemical composition of dust are highly dependent on geographic location. Therefore, we felt it to be appropriate to use dust samples from locations where solar power generation projects are planned. Also, due to the location-specific nature of the dust, dust used in EDS studies should also be systematically characterized. Thus, the limitations of the study and the possibility of extrapolating the results may be properly assessed.

Toward that end, we used dust that has been collected from a solar test facility and extensively characterized, the results of which have been recently reported [2].

It is also necessary to address the scaling effect. Studies reported in the literature typically use EDS prototypes that are significantly smaller than the size of typical commercial PV modules (see Table I). The EDS is a primarily capacitive load to the high-voltage source. With the electrode configuration (e.g., electrode width and electrode spacing) kept constant, the larger the EDS device, the larger the capacitance and the longer it takes to charge it for a given high-voltage source with limited current capacity [11]. As the size of the EDS increases, this scale-up effect related to electrical load increase could also affect the EDS efficiency. Until this study, there has been little knowledge about the scale-up effect on the EDS efficiency.

Another important factor in the EDS design is the dielectric cover thickness. The dielectric cover is an insulating material that separates the EDS electrodes from the ambient environment. It is essential for the safety and reliability of EDS. The thickness of the dielectric cover strongly affects the electric field strength on the EDS surface and should be expected to affect the dust removal efficiency significantly. Previous studies by different researchers have reported different dielectric cover designs and thicknesses. For example, the Waseda University research group has reported using 0.1-mm glass [4], while the Boston University group used 50-μm polymer materials as the dielectric cover [5]. However, it is useful to investigate the EDS dust removal efficiency with thicker dielectric cover materials that are more readily available.

In addition, there is a need to better understand the initial dust as deposited on the EDS as well as the “persistent dust,” i.e., the dust that remains on the EDS surface after alternating high voltage is applied. Understanding characteristics of the dust before and after EDS activation should be useful for improving the EDS design and for predicting the benefits of EDS. Recently, Sayyah et al. reported the particle size distribution of the dust before and after EDS activation [10]. In that study, the researchers collected the dust from the EDS and analyzed its particle size distribution using a light scattering method. The effects of humidity, tilt angle, voltage, and interelectrode spacing on the residual particle size distribution were investigated. However, there has been no report on the particle size distribution of the initial dust measured in situ before EDS activation as compared with the persistent dust after EDS activation. The light scattering method used in the previous study requires suspending particles in a fluid such as water. The advantage of this method is that it can get particle size distribution from well-dispersed individual particles. However, dust particles can also become agglomerated on the EDS, but the light scattering method does not provide information of the particle agglomeration condition.

The objectives of this study, therefore, were to determine the dust removal efficiency of EDS as a function of dust loading at levels relevant to solar PV applications, to determine the effects of EDS size and dielectric cover thickness, and to determine the particle size distribution in situ before and after EDS activation. Herein, we describe the methods and the results of this study.

II. METHODS

The methods used in this study are described as follows.

A. Dust Removal Efficiency Measurement

A “removable dielectric cover” method was used to measure the dust removal efficiency. A thin glass plate was used as a removable dielectric cover. It was placed over an EDS base. The removable dielectric cover was significantly smaller than the EDS base. In each experiment, we measured the efficiency of dust removal from the surface of the removable dielectric cover. It was assumed that the dust removal efficiency would be the same if the dielectric cover had been large enough to cover the entire EDS base. Provisions were made in this study to test that assumption, as described in the following section. The EDS base consisted of a substrate, electrodes, and a 55-μm Scotch tape covering and protecting the electrodes. Details of the EDS bases and the removable dielectric covers are given below.

The removable dielectric cover approach was necessary for gravimetrically determining the dust removal efficiency at lower dust loading levels, especially for larger EDS designs. When the dust loading is low, we need to be able to measure very small dust masses on the EDS. This would become technically impossible when the mass and the dimensions of the EDS exceed the capacity of the analytical balance. The removable dielectric cover method was, thus, created to address this problem.
Fig. 1 shows a schematic drawing of the experimental setup used in this study. Two Trek 10/10B-HS high-voltage amplifiers (Trek Inc., Lockport, NY, USA) were used to provide the two-phase high-voltage input for the EDS. Square wave control signal was provided to the high-voltage amplifiers, using a Tektronix AFG 1022 arbitrary function generator (Tektronix, Inc., Beaverton, OR, USA). The high voltage had a frequency of 1 Hz and three different levels of amplitude: 3, 6, and 9 kV<sub>pp</sub>. A Tektronix DPO 2004B digital phosphor oscilloscope was used to monitor the waveform of the voltage across and the current through the EDS electrodes, using voltage and current monitoring ports of the high-voltage amplifiers. The EDS was tilted at 20° in all experiments. The high-voltage parameters were intentionally chosen to be similar to those used in a previous study [4], so that a meaningful comparison of the EDS efficiency could be made.

In each run, a thin glass plate (as a removable dielectric cover) was first cleaned and weighed. The glass plate was then loaded with dust, reweighed, and then carefully placed on the EDS base. The thin glass plate then became a dielectric cover that covered a portion of the EDS surface. The EDS was energized for 10 s to 5 min depending on other parameters (see Table II) and stopped when there was no more visible dust repulsion from the glass plate. The thin glass plate was carefully removed from the EDS base and reweighed. The experiment was carried out in an air-conditioned laboratory where the air temperature and relative humidity were in the range of 20–22°C and 62–70%, respectively. A Discovery DV215CD semimicrobalance (OHAUS Corp., Pine Brook, NJ, USA) with a minimum reading of 0.01 mg was used for the gravimetric measurements.

The dust removal efficiency, or the EDS efficiency, was calculated from

\[
\eta_{\text{EDS}} = \frac{m_{\text{pre}} - m_{\text{post}}}{m_{\text{pre}}} \tag{1}
\]

where \(m_{\text{pre}}\) is the mass of the dust loaded onto the thin glass plate before being subjected to EDS action; and \(m_{\text{post}}\) is the mass of the “persistent” dust that remains on the thin glass plate after being subjected to EDS action. The mass of dust divided by the area of the thin glass plate is the dust loading.

### B. EDS Bases and Removable Dielectric Covers

Three types of EDS bases were used in this study, the main characteristics of which are presented in Table III. Two of them used glass as the substrate; and the third EDS base used polyethylene terephthalate as the substrate. A screen-printing technique was used to print silver line electrodes on the substrate. The electrodes were approximately 0.3 mm in width and 5–10 μm in height, with a spacing of 7 mm (electrode centerline to electrode centerline). The length of the electrodes was approximately 4 cm shorter than the length of the substrate. A sticky Scotch tape approximately 55 μm in thickness was applied over all the electrodes to provide insulation. Fig. 2 shows a cross-sectional schematic drawing of the EDS in its experimental position.

In this study, several types of thin glass plates, commercially available as smartphone or smartwatch screen protectors, were used as the removable dielectric cover. These thin glass plates may be organized into three-dimensional groups, as shown in Table IV. These glass plates were thicker than the dielectric cover used in the previous studies [4], [5]. They were chosen because of their commercial availability, which is an important factor in terms of potentially introducing EDS to the solar PV industry.
TABLE IV
INFORMATION OF THIN GLASS PLATES USED AS A REMOVABLE DIELECTRIC COVER

<table>
<thead>
<tr>
<th>Dimensional group</th>
<th>Length (mm)</th>
<th>Width (mm)</th>
<th>Thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>32</td>
<td>26</td>
<td>0.315</td>
</tr>
<tr>
<td>2</td>
<td>122</td>
<td>56</td>
<td>0.315</td>
</tr>
<tr>
<td>3</td>
<td>34</td>
<td>28</td>
<td>0.215</td>
</tr>
</tbody>
</table>

It was assumed that the EDS efficiency would be the same whether it was measured using a small thin glass plate that covered a fraction of the EDS surface, or it was measured with a thin glass sheet of the same thickness that covered the entire EDS surface. The EDS efficiency measurement results from using group 1 and group 2 thin glass plates (same thickness, different areal dimensions) were compared to evaluate that assumption.

C. Dust Used in the Study

The dust used for EDS efficiency measurement was collected from solar module surfaces in the Qatar Foundation Solar Test Facility located in Doha, Qatar. Typical dust accumulated on PV panels had a mass median diameter of approximately 20 μm. The dust consisted of calcite, dolomite, quartz, and other mineral components. Detailed information, including chemical composition of the dust, may be found elsewhere [2].

D. Dust Loading Method

Dust was deposited as evenly as possible onto the thin glass plate by manually shaking the dust through a sieve held about 20 cm above the plate. A 75-μm ASTM E11 standard sieve (Gilson Company, Inc., Lewis Center, OH, USA) was used for that purpose.

Images of as-deposited (pre-EDS) dust particles at a loading level of approximately 800 mg·m⁻² were acquired using a Leica DM2700M RL/TL optical microscope (Wetzlar, Germany) with a 2.5× objective lens. The persistent dust on the glass plate (post-EDS) was also imaged. These images were processed using an ImageJ program (imagej.nih.gov/ij) to obtain particle size distribution of the deposited dust [12]. ImageJ’s built-in standard particle size measurement was adopted, which defines particle size as a diameter of an equivalent circle of the equal projection area. The watershed transformation option based on the Euclidian distance map algorithm was also applied to the particles images, so as to count the components of agglomerates as individual particles [13]. The particle diameter distribution by area percentage obtained through ImageJ was converted into percent volume distribution in order to compare with laser diffraction size distribution of dust samples collected from PV panels reported in our previous study [2].

III. RESULTS AND DISCUSSION

The pre-EDS dust loading used in this study ranged about four orders of magnitude, from approximately 200 mg·m⁻² to 100 g·m⁻². The lowest dust loading was approximately equal to the dust accumulation on a PV panel exposed in a dusty environment for 2 days [2]. The highest dust loading level was only used for comparison of results with other studies [4], [5]. Immediately upon application of alternating high voltage, dust particles could be seen jumping off the removable dielectric cover. The high voltage was turned off after 10 s to 5 min depending on dust loading, when all visible particle motions were completed.

A. EDS Efficiency at Solar PV Dust Loading Levels

The dust removal efficiency results are shown in Fig. 3. The uncertainty of the dust removal efficiency was obtained from an uncertainty analysis of the EDS efficiency as a function of pre-EDS and post-EDS dust mass values [14], using a dust mass measurement uncertainty of 0.01 mg. In all cases, a higher voltage resulted in a higher dust removal efficiency due to a stronger electric field, as observed by other researchers [4]. At the highest dust loading of 100 g·m⁻², with the 0.215-mm glass plate and at the voltage of 6 kVpp, the dust removal efficiency was about 90% for all three EDS devices (see Fig. 4). This value was similar to or even greater than that reported by Kawamoto and Shibata under similar conditions [4]. It should be noted that a 0.1-mm glass dielectric cover was used in the study by Kawamoto and Shibata.

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**Fig. 2.** Cross-sectional schematic drawing of the experimental setup (not to scale).

**Fig. 3.** Dust removal efficiency of the 14-cm EDS with the 0.215-mm removable dielectric cover.
However, the EDS efficiency was significantly lower at low dust loading levels. The EDS efficiency generally increased with increasing dust loading, and, in some cases, decreased with further increase of dust loading. At the lowest dust loading (approx. 200 mg m\(^{-2}\)), the EDS efficiency was about 60\%, at 6 kV\(_{pp}\) with the 0.215-mm glass dielectric cover. The dust loading of 200 mg m\(^{-2}\) is what could be accumulated on an initially clean PV panel in a 24-h period, under typical desert conditions [2]. Therefore, if we have a PV panel equipped with EDS, and we operate the EDS every 24 h, we can predict the cleaning efficiency of the PV panel based on the result obtained in this study. Certainly, the accuracy of such prediction will depend on how well the lab experiments simulate the field operating conditions.

Obviously, it is desirable to know the efficiency of EDS that operates in the field more frequently than once every 24 h. This would require knowing the EDS efficiency at even lower dust loading levels. Unfortunately, the uncertainty of EDS efficiency result is inversely proportional to the pre-EDS dust mass, and eventually determined by the mass measurement uncertainty [14]. For example, at the lowest dust loading 200 mg m\(^{-2}\), the dust mass on the thin glass was approximately 0.2 mg. In comparison, the mass measurement uncertainty, defined as the range of repeated mass readings of the same sample, was 0.01 mg. The uncertainty becomes very large for very low dust loading levels. Therefore, we did not use dust loading levels below 200 mg m\(^{-2}\) in this study. This limitation should not diminish the value of this study, as it has reached a dust loading level that is sufficiently low to be relevant to solar energy field operations. It is also possible to predict the EDS efficiency at even lower dust loading levels, through extrapolation of the results.

The dust removal efficiency results obtained using thin glass plates from dimensional groups 1 and 2 were similar (data not shown). This suggests that we could use a small removable dielectric cover to measure the dust removal efficiency, and the result should be similar to if the entire EDS surface were covered with a dielectric cover of the same material and thickness.

### B. EDS Size Effect

Fig. 4 shows the dust removal efficiency of three EDS sizes using the same removable dielectric cover, at 6 kV\(_{pp}\) and 1 Hz, at various dust loading levels. The uncertainty bars were omitted for clarity of comparison. (The uncertainty bars for the 14-cm EDS results can be seen in Fig. 3.) The three EDS sizes appeared to have slightly different dust removal efficiency values, but the variation was about the same magnitude as that of the uncertainty of the results. These results suggest that a large EDS should be as efficient in repelling dust as a smaller EDS. This fact would not doubt offer some convenience in product development. In other words, one could fabricate and test smaller prototypes in the design selection process and only scale-up selected designs for full-size tests, so as to reduce development cost.

Developing EDS devices that are large enough to cover commercial PV modules will not be a trivial undertaking, as a preliminary study has recently suggested [11]. It will require solutions for manufacturing tasks such as electrode printing and encapsulation/lamination of the EDS onto PV modules. Research is also needed to develop solutions for the delivery of high voltage on a large scale, in order to energize EDS on hundreds or even thousands of solar panels.

### C. Dielectric Cover Thickness Effect

As noted in the previous section, the dust removal efficiency in this study with the 0.215-mm glass plate was similar to or even greater than the result with a 0.1-mm glass plate that had been reported by Kawamoto and Shibata at the same dust loading and voltage amplitude. However, as seen in Fig. 5, the dust removal efficiency dropped drastically when the 0.315-mm glass plate was used. With the 0.315-mm glass plate (0.37 mm total dielectric cover thickness), the dust removal efficiency was only half the efficiency with the 0.215-mm glass plate (0.27 mm total dielectric cover thickness). From an EDS efficiency standpoint, a thinner dielectric cover is no doubt more advantageous. However, cost of thin glass sheets and the fabrication difficulty using thin glass dielectric cover may also be dependent on the thickness. We hope that future technology development and market growth of thin glass products will help facilitate the development of the EDS technology.
D. Particle Size Distribution of Initial Dust and Persistent Dust

With the help of light microscopy, we were able to gain some knowledge of the microscopic condition of the initial dust and the persistent dust on the removable dielectric cover. Fig. 6 shows the initial dust as deposited on the removable dielectric cover and the persistent dust after EDS activation. The figure consists of photomicrographs of dust on a 0.215-mm glass plate, before and after being subjected to EDS operation at 6 kV"\text{pp}" and 1 Hz. The initial dust loading shown in the photomicrograph was approximately 800 mg·m"\text{−2}". The initial dust consisted of primarily large agglomerates. There were very few nonagglomerated particles in the initial dust. This is very different from observations of dust particle accumulation in the field. In the field, when dust accumulates on an EDS surface, the particles should be nonagglomerated initially; agglomeration would only occur when the dust loading is so high that additional particles had high likelihood of landing onto other particles [15]. Shaking dust through a sieve is a convenient way to deposit dust onto EDS for testing, but it is not an accurate way of simulating natural dust deposition. A better way to mimic the natural deposition of dust is to aerosolize powder dust first and let the aerosolized dust fall onto the EDS surface. Such a method should be considered for future laboratory EDS studies.

The agglomerates in the initial dust apparently disintegrated during EDS activation, as only remainders of the agglomerates were visible in the persistent dust. These remainders were seen in regions far away from the electrodes, but they were absent in the vicinity of the electrode (within about 1.5 mm from an electrode). This is consistent with the fact that the electric field strength is weaker at locations farther removed from the electrode. (Locations at the top of the photomicrographs were about 4 mm from centerline of the electrode. Therefore, the region at the top of the image was the most removed from the electrodes, and hence having the weakest electric field strength.) Compared to the initial dust, there is a noticeable increase in the number of small particles in the persistent dust. Apparently, many individual particles that constituted the agglomerates were torn away from the agglomerates by the electric field forces and other forces. Some of these particles were eventually repelled from the EDS, but some remained on the dielectric cover after being torn away from the agglomerates. There is an especially high concentration of small particles over the electrode. These small particles were apparently attracted to the electrode, but were not able to be repelled from the electrode. The detailed mechanism for this phenomenon is not yet known and will be worth investigating in future research.

The light microscopy data also allowed us to obtain quantitative particle size distribution information of the initial dust and the persistent dust. Fig. 7 shows the size distribution (by volume) of the initial dust and the persistent dust. Because the different materials in the dust were very similar in density [2], the size distribution by volume was essentially the size distribution by mass. Therefore, evaluating the dust removal efficiency by volume is the same as evaluating the dust removal efficiency gravimetrically. Fig. 7 shows that there were very few particles below 20 μm in the initial dust. This is because in the initial dust, the smaller particles were almost all part of the large agglomerates (see Fig. 6). The small particles “hidden” in the agglomerates would become observable after the disintegration of the agglomerates caused by EDS activation. As can be seen that, compared to the initial dust, there is a significant increase of particles <20 μm in the persistent dust, while several large particle size “bins” were empty in the persistent dust. Larger particles were more likely to be repelled because the EDS is less efficient in repelling smaller particles, as for smaller particles, the adhesion forces are more likely to be greater than the repelling forces [16]. Based on our previous study, roughly half of the dust (by volume) accumulated on a PV panel consists of particles smaller than 20 μm [2]. Therefore, how to efficiently...
remove these small particles from solar panels will be a serious challenge to EDS.

Despite the significant difference in the EDS technology and the dust sample, it might be useful to compare this study with another study [10]. In the study by Sayyah et al., the authors did not report the absence of small particles in the initial dust. This is because the method used in that study does not report the conditions of the dust particles as they were deposited on the EDS. Instead, the particles were collected from the EDS surface and suspended in water for particle size distribution measurement based on the Mie scattering theory. Any agglomeration of the dust particles would have been effectively broken in that process. The authors reported a shift of particle size distribution toward the smaller particles in the residual dust. This is because larger particles were repelled with a higher efficiency, as we have also observed in this study. Both approaches demonstrate the EDS efficiency dependence on particle size. One characteristic of our approach is that it counts an agglomerate as a single particle. However, because of this characteristic, our approach is able to report the agglomeration condition of the dust, which the light scattering method is incapable of.

IV. CONCLUSION

This study affirmed some previously observed effects, such as the increase of the EDS efficiency with increasing voltage amplitude, and the particle-size dependence of dust removal efficiency. However, the study also produced a number of findings that had not been available from the previous studies, such as the effect of dust loading at levels relevant to solar PV soiling, effect of dielectric cover thickness, and the particle agglomeration condition of the dust deposited through mesh sieves. From these findings, we can draw the following conclusions:

1) Dust removal efficiency at dust loading levels relevant to solar PV applications can be significantly lower than the EDS efficiency at high dust loading levels.
2) Large EDS devices should offer dust removal efficiency similar to that of smaller EDS devices with the same electrode width and spacing.
3) Using a thinner glass as a dielectric cover, generally, results in a higher dust removal efficiency for EDS.
4) Depositing dust through a sieve leads to particle agglomeration in the as-deposited dust. This causes the absence of particles smaller than 20 μm in the apparent particle size distribution of the deposited dust. Such apparent particle size distribution is very different than that of the naturally deposited dust. The dust removal efficiency measured with the dust deposited through a sieve could be different than that measured with the naturally deposited dust. Experiments with the naturally deposited dust (or simulated) are needed to address this issue.

REFERENCES


Authors’ photographs and biographies not available at the time of publication.