Using Alpha Ionization to Optimize Performance of a Spin Station

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Spin Stands are widely used by the disk drive industry to evaluate and certify drive sub assemblies such as media. The tool provides a spindle on which to mount the media and spin it up to operating speed. Because of the very high areal bit density, it is necessary for the stand to operate smoothly. To that end, the spindle operates on an air bearing. The air bearing separates the spindle and the media from ground and represents an ESD hazard to the very sensitive MR head. The media can arrive with charge on it caused by triboelectric charging in the handling process or it can become charged as it spins, being tribocharged by particles in the air. In either case, as the head moves in, it can receive a discharge from the media.

The spin stand uses a mechanical contact between the spindle and ground. A metal button contacts the bottom of the spindle to provide the ground. See Figure 1.

Unfortunately, the button wears over time and eventually starts to "chatter" and thus must be replaced. Replacement involves removing the entire spindle assembly from the tool and unscrewing the ground button then finally eplacing it. Once the equipment is reassembled and replaced in the base of the stand, it must be realigned. All in all this replacement process take the tool off line for over an hour.

Spin stands used in disk drive operations must protect their MR heads from discharge from the media. The unit has a mechanical ground button, which wears and causes micro-chatter, degrading the measurement accuracy. Ultimately the button must be changed. Some wear out in a month and some last nearly a year.

A better solution utilizes an alpha ionizer, which makes no physical contact and causes no mechanical issues. It provides service-free operation for a full year and is quick and easy to change.

Air Ionization – A common solution to static charge on isolated conductors is the use of air ionization. This creates negative and positive air ions in the atmosphere and is an effective mechanism for discharging the charged device. The ions of one polarity are attracted to any static charge of the opposite polarity and serve to neutralize it. The opposite polarity ions are repelled and eventually find ground and are neutralized. See Figure 1.

Ionizer Technology – Air ionizers are available with a variety of technologies. By far, the most common are corona and alpha. Corona is very versatile but not the best choice for this application. It must be adjusted very accurately to avoid any electrical offset, which on the media could easily cause damage to the head. Corona ionizers use airflow to drive the ions to the target part. This is disruptive to the operation of the spin stand. Air ionization generates positive and negative air ions, which seek out surface charge and neutralize it. Positive ions neutralize negative surface charge and negative ions neutralize positive.

Corona Ionization – The most common technology for air ion generation uses the corona effect. These ionizers use high voltage on sharp points to create an intense electric field, which in tu n ionizes air molecules. A fan is used to drive the ions to the charged object. The fan contributes to the size of the ionizer and limits the temperature range over which the ionizer may be used.

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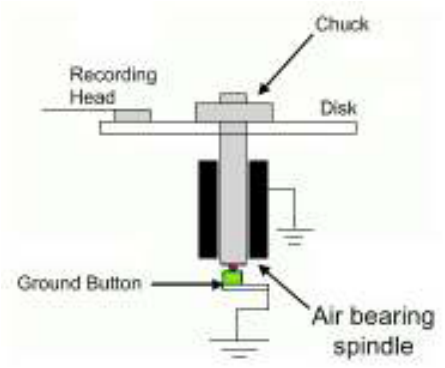

Figure 1: Grounding of a spin stand.

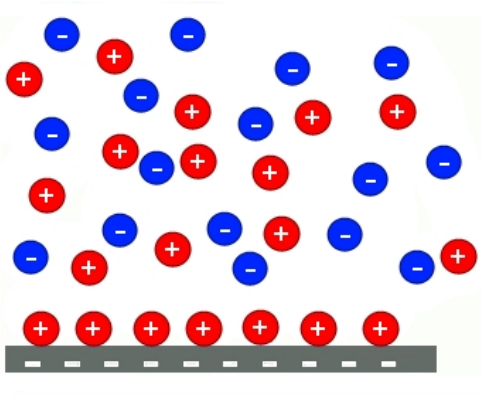

Figure 2: Use of air ionization to neutralize static charge.

It is critical to match the positive and negative voltages very closely. Imperfect matching causes the ionizer to discharge objects in the environment to a voltage other than zero called the offset voltage. If the ionizer is sufficiently out of balance, it is an ESD haza d itself. See figu e 2. The closer the ionizer is placed to the product, the faster the discharge time but the greater the offset voltage. Causes of such imbalance are drift, improper adjustment and contamination. A corona ionizer becomes contaminated because its high voltage causes it to act as a dust precipitator. Corona ionizers need to be cleaned and adjusted several times a year. When the ionizer is placed inside of the process tool, for example a handler, cleaning and adjusting can be difficult when the ionizer is not easily accessible.

Alpha Ionization - An alpha ionizer works by a completely different method. Alpha particles from the ionizer traveling through the air, strike air molecules and ionize them. More than 100,000 air ion pairs are created by each alpha particle. These can be located as close as 1" from the source in comparison with corona ionization, which must be kept further away to avoid significant o fset voltages. The alpha ionizer is inherently balanced by virtue of conservation of charge. Further, the ions are delivered to the charged surface, in this case the media, without need for airflow. For mo e detail on alpha ionization, see Application note LBL-AN 001

Ion Design-In Considerations

The alpha ionizer that is best suited for the spin stand application is the NRD P-2042. It is shown in Figure 3. It is a disk of diameter ~1" with the alpha active material imbedded in gilded material behind the screen shown in the photograph.

The floating assembly, which can become cha ged, includes the spindle and the media. Both are electrical conductors, so placing the ionizer 1" from any part of the media and spindle assembly will discharge the disk and protect the head. One implementation is shown in Figure 4. The location of the P-2042 should be chosen to avoid interference with moving parts within the system.

Note that the P-2042 must be grounded to achieve the perfect voltage balance that is required for this application. The P-2042 is covered by insulating plastic labels, making electrical contact with the unit difficult. o deal with this issue, there is a section of the perimeter of the unit that is left uncovered so that grounding can be achieved at that point. Contacting the bare part with a pinch screw will provide a good ground.

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Figure 3: The P-2042 alpha ionizer is compact.

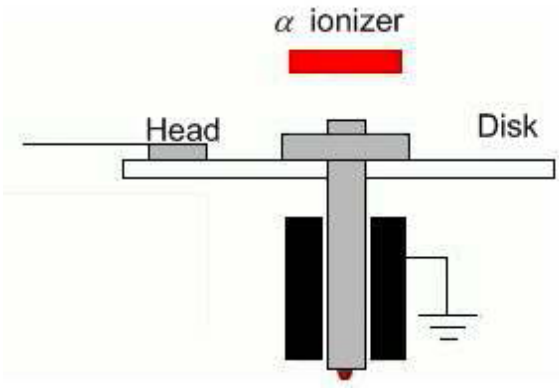

Figure 4: The alpha ionizer needs to be placed 1" from the floating ha dware.

Measuring Voltage Balance - The P-2042 was placed in proximity to the spinning structure as shown in Figure 5. With the source grounded and 1" from the disk, the voltage balance delivered by the ionizer was measured using the setup shown in Figure 6. The ground button was still in place, but the connection was made to the Keithley electrometer (input impedance > 2x1014). The capacitance to ground of the stand assembly is ~ 100 pF. Thus the time constant of the Keithley and spin stand system is ~5 hours so leakage current caused by the electrometer is completely negligible over the 5 minute measurement time.

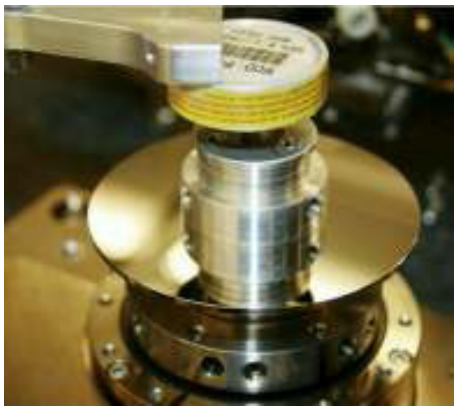

Figure 5: Placing the P-2042 in proximity to the disk and other electrically floating material

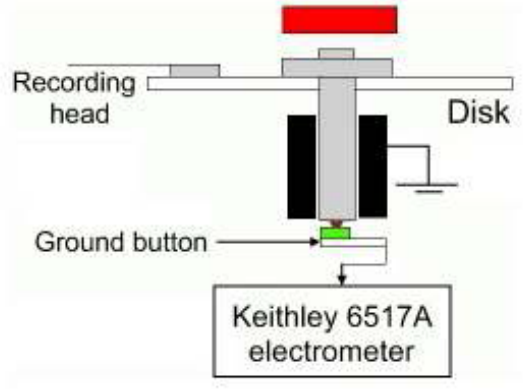

Figure 6: Measuring the electrical static charge control properties using a keithley electrometer.

The results showed that the disk assembly was held immeasurable even though the accuracy of the system was <200 mV. This means that the voltage balance achieved is perfectly acceptable for protecting the head.

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Measuring Discharge Speed – The conventional method for measuring discharge speed is called the discharge time. As defined by ANSI/ESDA STM 3.1-2000. This involves measuring the time t discharge a 20 pF plate from 1000 V to 100 V. This measurement was made using a MKS Ion Systems 210 Charge Plate Monitor with its analog output connected to a LeCroy 9345 digitizing oscilloscope. A grounded P-2042 alpha ionizer was placed 1" above the center of the plate. A discharge time of < 200 msec was achieved for discharges from 1000 V to 100 V and for 10 V to 1 V. For the later measurement, the plate was touched by a lead from a 10 V DC power supply. See Figure 7. It was decided, however, that this measurement was not representative of the performance of the system owing to the higher capacitance of the plate mounted on the spindle.

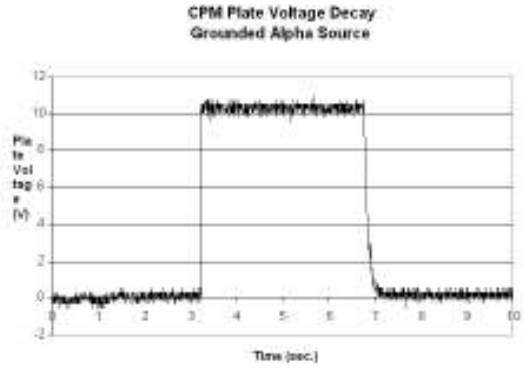

Figure 7: Discharge of a 20pF CPM plate.

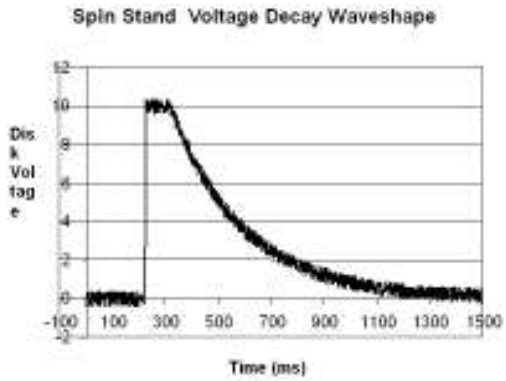

Figure 8: Waveshape for discharge of disk on a spin stand.

To make a better estimate of the speed at which the disk is discharged, the setup in Figure 6 was used with the analog output of the Keithley connected to a LeCroy 9354 digitizing oscilloscope. This measurement produced a discharge like the one shown in Figure 8. This shows a discharge from 10 V to 1 V in ~650 ms. The measurement was confi med by measurement of the disk voltage with a Trek 400 non contacting electrostatic voltmeter to assure that the input impedance of the Keithley had no effect upon the measurement. The Trek voltage sensor was located 0.25" above the disk. The results of the measurement reproduced the measurements made with the Keithley electrometer. Thus, it is safe to say that any charge on the disk will be dissipated in well under 1 second.

Conclusions - The alpha ionizer is a superior replacement for the ground button on the spin stand. It provides continuous protection of the head with no need for cleaning or adjustment of the ionizer as would be required for a corona ionizer. The alpha ionizer drives the voltage on the disk to zero in well under 1 second, protecting the MR head from damage due to electrostatic discharge.

Removing the ground button and switching to the alpha solution eliminates the need to change the ground button several times a year. For most configurations, it is possible to pe form the required annual alpha ionizer replacement in just a few minutes, with no alignment or calibration required. In contrast, replacing the ground button requires removal of the spindle assembly from the stand, replacement of the button and then it is necessary to perform a realignment procedure. Such a procedure requires about one hour each timeand in production applications, this can represent a significant cost due to the unavailability of the stand during the maintenance p ocedure.

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