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Degradation of Electronic Devices Overtime

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A B S T R A C T

This study addresses a different degradation mechanism in electronic devices occurring because of the combined effects of electrical field and temperature. It's observed that voltages beyond a particular value cause to fracture in electronic devices. Irrespective of the cause of overheating, the final and first effect of overheating on any electronic component is damage. In this paper, the consequences of excessive levels heat on different kinds of electronic components are explored and discussed. Note that included during this discussion are the causes of overheating to higher understand and appreciate the overheating phenomenon because it applies to electronic components, in addition as electronic assemblies and electronic devices. Through a review of literature, especially studies and engineering reference materials, this paper discovered out that at the micro-level, overheating causes material degradation on or in a much selected electronic component. This degradation is additionally caused by cracks, expansion, and other structural deformation. Note that this degradation is also caused by different changes within the physical and chemical properties of a specific material due to exposure to high levels of heat. At macro-level, the effects of overheating centre on systems failure due to degradation of different constituents and components, cause effect loop, and neigh boring-effect. Both micro-level and macro-level effects of overheating on electronic components increase the health and safety risk of a complete electronic assembly and device. Hence, through a review of literature, this paper also discusses the techniques or processes for preventing overheating or reducing the negative effects of excessive levels of temperature.

Keywords: Degradation Mechanism, Electronic Devices, Electronic Components

1. Introduction of Bone Implantation

Electronic components like integrated circuits, transistors, resistors and capacitors, among others are designed and built to stand particular levels of heat. Note that when used in an electronic system such as an actual consumer electronic device, most of these electronic components generate heat. However, many internal as well as external conditions can lead in overheating that can damage an electronic component of the system. This research paper explores and discusses the effects of heat or more appropriately, of overheating of electronic components.

Overheating may be a result of direct and indirect, as well as internal and external influences. This means that there are different factors at play why an electronic component becomes subjected to excessive levels of heat.

The consumer electronic devices such as portable laptops and smartphones are becoming more prone to overheating. This is because the physical dimensions of these devices are becoming smaller. To be specific, as demand for smaller devices becomes higher and more taxing, manufacturers of electronic components need to pack transistors into even small areas, and this cluttered engineering device increases overheating due to reduced thermal flow. In other words, design and engineering problem can be a direct and internal cause of overheating. Faulty contact or contact wiring can result in overheating and sparks that can further generate fire. Furthermore, multi-physics coupling engineering considerations, especially those that take into account the electric and temperature fields in the design of electronic components are inherently problematic.

Excessive power dissipation results in the rise of temperature that can go beyond the capacity of transistors resulting in capacitor failure. Leakage current is another specific cause. A higher leakage current generates higher temperature across the capacitor due to loss of power.

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Humidity or the high moisture content of the surrounding air can also result in overheating because water vapour can contaminate electronic components and erode metal components or cause a short circuit. Of course, the hot temperature can promote internal overheating as well. Using a PC or a laptop in a hot temperature will make internal warmth distribution less efficient. Other causes of overheating are external bad contact and bad wiring that can lead to excessive voltage surges and power dissipation, improper use of an electronic device such as using an incompatible auxiliary device as exemplified in using unrated cables and power adapters, overclocking of hardware components of computer devices, improper storage, and misuse and abuse, among others.

Damage to an electronic component is the potential and direct effect of overheating. This is especially true if the component is unable to withstand the excessive levels of heat. Note that most, if not all, of failures in electrical and electronic components, are commonly associated with overheating and subsequent burning. This is why systems failure analysis of electronic components typically involves examining for evidences or indications of overheating and burning.

2. Objective

The primary goal of this research paper is to determine the effects of overheating on electronic components. Aside from this, however, this paper also explores and discusses the different facets of overheating as far as electronic components are concerned. Thus, this paper also determines the causes of overheating and provides recommendations on how to protect electronic components from the damaging effects of excessive heat. These goals and objectives are achievable by referencing and reviewing related literatures.

3. Discussions

Overheating can be a term affecting the performance and lifeline of our electronic devices. Studies says that the impacts of excess heat can cause micro and macro levels of degradation. The micro-level overheating causes material degradation in an exceedingly specific electronic component. This degradation is due to the cracks, expansion, and other structural deformation of the componenets. The macro-level overheating effects on systems failure thanks to degradation of various constituents and components.

Both micro-level and macro-level effects of overheating on electronic components increase the health and safety risk of a complete electronic assembly devices.

If you would like to make sure that your equipment remains operational for a protracted time, you should ensure to make sure to keep them operating at a snug, cool temperature. Placing the A/V equipment inside a ventilated cabinet or closet, allows sufficient cool air flowing through the cupboard to hold away any excessive heat. If there’s no extra head room for airflow, the temperature will keep rising until the system has fried itself.

Active ventilation is another means to avoid overheating, where ventilation fans or blowers create movement of the air and thus reduces the surplus heat.

Leave some empty space on both sides and above the equipment. This provides your system’s components some room to breathe in order that cool air can flow all around. When a stream of cooler air meets a pocket of warmer air, the warm air is caused to rise to the top of the cabinet. Installing your equipment during a tight space allows them to breathe the same hot, recycled air rather than of the cool and fresh air around.

As weknow over time, dust overcomes everything. When the ventilation holes get clogged, sufficient air cannot be pulled through to cool down the components. Which restricts the air intake to the energy supply, leading to overheating the energy supply which can blow up. Try to dust your system components often (at least once a week) clean around the top and bottom vents ofevery piece to avoid clogs. Here’s a small tip, keep fans and vents clean with canned air dusters and brushes. This reduces fan noise since the fan wouldn’t have to work as hard to spin the blades comparatively.Other than installing proper ventilation, the wattage of your electronics is another heat building factor. The number of power the system consumes directly determines the proportion of heat generated.

Now that you understand how your Audio Visual equipment could be impacted by overheating, as well as its preventive measures, we hope these tips were helpful to improve the lifespan of your equipment.

Compact electronic devices with large power requirement and miniaturized electronic components are susceptible to overheating because of the small area and limited dimension that makes heat transfer less efficient. Of course, poor design and engineering are also direct and internal influences. There is a high possibility that substandard electronic components or assemblies and devices might overheat due to lack of quality control and proper rating during their production. Aside from direct and internal influences, indirect and external influences can cause overheating. Examples of these are environmental weather conditions or ambient room temperature that can either promote overheating or lead to material degradation that will eventually result in overheating. High levels of humidity can cause overheating because of poor heat transfer and possible moisture contamination of electronic components. Other examples of indirect and external influences are improper use or misuse and abuse of electronic component, specifically of an electronic assembly and electronic device. Regardless of the effect of overheating, the final and first effect of overheating on an electronic component is damage caused to it. This damage primarily affects the involved electronic component, but it can also affect other components in an assembly, thus resulting in overall system failure of the assembly or an electronic device. The aforementioned discussions provide a clear exploration and understanding of how exactly excessive levels of heat affect or damage different types of electronic component. One specific effect is material degradation. Electronic components such as ceramic capacitors and diodes are prone to cracks to overheating. After all, heat causes a material to expand. In a component composed of different constituents such as an OLED, cracks are also inevitable due to the different thermal coefficient of expansion of the materials. The heat essentially subjects different materials in different rate and size of expansion that on a collective level, result in disintegration.

Damaging and cyclic interaction between particles are also another effects of overheating. This phenomenon has been observed in minuscule semiconductors such as a thin silicon wafer. Concentration of electrons in the silicon wafer causes the electrons scattering the phonons. Such scattering prevented the phonons from carrying away heat. Thus, under heat, the electrons packed in a semiconductor packed become excited. However, heat escape is possible because the packed and excited electrons result in the scattering of phonons. Phonons are essential in heat transfer. Overheating also affects the more specific constituents of an electronic component. Exposure to excessive levels of heat can lead to fatigue fracture surface of conductive materials such as copper. Overheating can also result in in different microstructures and crystal orientation of materials such as Terfanol-D alloy. Other effects of exposure to excessive levels of heat are evaporation of metals, or other materials usedin soldering or in gluing together different parts of a particular electronic component or an electronic assembly. Nonetheless, these effects are indicative of the fact that overheating causes changes in the physical and chemical properties of specific constituents found in an electronic component. The secondary effects are material degradation of the actual constituents and subsequent failure of the electronic component. The variations in the physical and chemical properties affects the operation and function of an electronic component. There are also other macro-scale effects of overheating. Certain types of capacitors, when exposed to high temperatures beyond their threshold capacity tend to burst and combust. This results in widespread damages in an electronic assembly. Combustion can result in fire obviously. An electronic device might explode and cause serious harm and danger. This phenomenon has been observed in capacitors and the different components of batteries. From the aforementioned effects of overheating of electronic components, it is safe to conclude that the most general and more troublesome effect is the dangers to end consumers. Apart from specific mechanical failure or systematic failures, an overheated electronic component, electronic assembly, or electronic device can cause serious injuries. A device, for instance, may explode and injure a user. It can also cause a fire. Because of this generalized effect, recommendations are given in the subsequent discussion. These recommendations explore the techniques or processes used to prevent overheating.

In bio medical industry, orthopedics segment has rapidly grown. Hip implant generally developed by traditional molding process such as sintering, investment wax molding which revealed some issues in patient's body such as ARMD, particle wear off, blood clogging into blood stream. Besides these, loosening or misalignment of traditional implant among some patients who has some unique health as well as body structure requirements either pre surgery or post-surgery. In such cases surgeons recommends customized implant which either can be developed by traditional molding process or additive technology but presently it is costlier. Hence patient suffers such issues as well as pays high cost with longer painful time. Such issues can be overcome by additive technology process with accessible machine with new material with developed design.

4. Background Study/ Literature Review

The susceptibility an electronic assembly or electronic device to fail increases exponentially with temperature (Cengel&Ghajar, 2015). In addition, there is a relationship between the performance, including the lifespan or lifecycle of an electronic component and its particular range of operating temperature (Mehoke, 2005). Temperature can essentially dictate the efficient performance of electronic components, as well as how long, will last. Several studies have uncovered and discussed how exactly overheating affects a particular electronic component. One dated study (Korotkov, Samuelsen, &Vasenco, 1994) investigated the effects of overheating in a single-electron transistor or SET by directly and artificially applying excessive amounts of heat through current flow. The researchers demonstrated that the temperature of the central electrode of the SET remains finite because of the effects of electron tunneling. Note that electron tunnelling is a phenomenon in which an electron moves through an energy barrier because fo the accumulation of energy. In the research, the heat applied to the set resulted in an electronic tunnelling that decreased the temperature difference between the central and outer electrodes. Further excessive warmth caused the hysteresis in the IV curve of the SET. Most of the hysteresis effects are intentional and needed in most of the electronic components, the researchers noted that the hysteresis they observed in the overheated SET showed a bi-stable characteristics.

Overheating also triggers damaging and cyclic interaction between particles. Another study (Liao, Maznev, Nelson, & Chen, 2016) investigated the interaction between electrons and photons in a thin silicon wafer under the normal and excessive level of heats. To do this, the researchers used a three-pulse photo-acoustic spectroscopy. The investigation revealed that increasing the concentration of electrons in the silicon wafer resulted in electrons scattering the phonons. Such scattering prevented the phonons from carrying away heat. The findings essentially demonstrated a cause effect loop of overheating. A little piece of silicon or any semiconductor studded with electrons would basically generate heat because of their small area. Moreover, the study revealed that more heat would be generated further because more electrons result in the scattering of phonons.

There are technical and non-technical, also direct and indirect ways for preventing overheating. Within the dated study of Korotkov, Samuelsen, &Vasenco (1994) that involved investigating the consequences of overheating during SET, they recommended that one in all simplest ways to minimize heat in the centre of an electrode of a SET is by increasing the area and thickness of the same. Doing the same will increase the heat flow from electron gas to phonons. It would also reduce thermal boundary resistance, thus reducing the resistance of the central electrode to thermal flow and allowing it to become resistant to too much heat to a certain extent.

Other way is the application of various enabling technologies for efficient cooling of the components . This is mostly true in components which have a multiphysics coupling systems. As said by Dede, Lee,& Nomura (2014), in evaluation the performance of any electronics systems that are designed after a multi-physics coupling engineering consideration, a mixture of heat conduction, convection, and radiation should be assessed and evaluated. They recommended the use of conjugate or solid-fluid heat transfer that includes the usage of a liquid thing that efficiently interacts with a heat sink to transport heat by conduction by through free or forced convection. The liquid substance is essentially the main transporter of heat as it travels through an electronic system. There are also other engineering and design considerations to prevent overheating. In capacitors, for example, a guideline (EE Publishers, 2014) mentioned that appropriate print circuit board layout techniques in which capacitors are placed away from other electronic components that tend to generate heat have been practiced by a lot of manufacturers. Integrating a heat-radiating protector between a capacitor and heat-prone electronic components is also a standard practice. Soldering should also be kept within the temperature profile of a specific type of capacitor. Note that this process creates heat, and excessive soldering can result in thermal stress and thermal damage.

Note that there are specific subfields and concepts in engineering that are designed or conceptualized to tackle overheating. Take note of thermal management as an example. A chapter (Mehoke, 2005) in the book about space systems introduced the use of thermal control subsystem in a spaceflight program. Accordingly, the goal of this subsystem is to control the temperature of all electronic components within a spacecraft during its entire operation. Such components include computers, instruments, and scientific sensors, among others. A standard practice in spacecraft technology is to ensure that an entire electronic assembly, electronic device, or equipment will not fail due to the overheating and subsequent failure of a specific electronic component. Another practice is to employ a failsafe mechanism in which operability and functionality will remain in case of electronic component failure. This is done by having a spare component or through the process of isolation. A reference material (Cengel&Ghajar, 2015) about the fundamentals and application of heat and mass transfer outlines and discusses the different considerations in thermal management. Accordingly, one of the ways to ensure that a component will operate and function properly despite exposure to heat is the determination

5. Conclusion

To reiterate the scope of this research paper, it is important to stress out the fact that heat is a normal byproduct of an electronic component or an entire electronic assembly that is under operation. This is the reason why electronic components are designed and built to overcome certain levels of heat. But, excessive levels of heat results in overheating than in turn, causes damages to any electronic component.

Remember that from the discussion above, overheating may be a result of direct and indirect, as well as internal and external influences. Direct and internal influences usually pertain to the design and engineering considerations that make an electronic component or an entire electronic assembly prone to overheating.

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