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RESEARCH ARTICLE OPEN ACCESS

Corrosion in Electronic Devices and Sensors to Prevent Corrosion

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Abstract
Many types of metal and alloys are used in various electronic devices and components like computers, microchips, printed circuit board (PCB), integrated circuits, transistors, and diodes etc. Such components have variety of applications in the field of medical, aerospace, automotive sectors, telecommunication and defense. These components are exposed to different types of environments. The increased used of electronics has also increased the demand for reliability. The size of electronic equipment is also very significant parameter and it has been decreasing presently at a faster rate. The smaller size of equipment has undetectable failures. Though the corrosion taking place in electronic components is generally of micro level which can not be detected easily but the services of device are seized.
The paper deals with the various types of corrosion in electronic components as a case study and an approach towards development of some sensor for corrosion monitoring.

I. Introduction

Corrosion is the process of gradual deterioration of a metal from its surface due to the unwanted chemical or electrochemical interaction of metal with its environment. The corrosion of metal causes loss of metal, unpleasant appearance, high maintenance cost and finally service failure.

Electronic industries are the major field of application in present scenario. Electronic devices have vast applications in various fields of medical, aerospace, automotive sector, telecommunication, defense as well as various house hold equipments like television, cell phone, electrical appliances with digital display etc [1]. These devices are operated in varying climatic conditions. Several environmental factors play significant role in proper service of electronic equipments. Some of the common problems caused by corrosion in electronic components are: Destruction and loss of materials, Nasty appearance, Increase in contact resistance, Leakage current, Soldering detachment, rusting on steel part, Oxide layering, Short circuit and Operation failure

The factors that affect corrosion in electronics are: Moisture and humidity, Corrosive gases, Accumulation of Dust particles, Microbes, Heat, Solar radiation, Interruption in power supply, Low or high voltage, Loose fitting of connections, Mechanical vibration, Dissimilar metals such as gold and aluminum (Au & Al) in contact, Presence of an electrolyte at the interface of two dissimilar metal contacts etc. [2]

Some of the main components of an electronic device which are prone to be corroded or damaged due to environmental impact resulting to an inadequate service or a system failure are Integrated Circuits (ICs), Printed Circuit Board (PCB), Transistors, Capacitors, Diodes, Switches, Cable connectors, Magnetic Recording Media (Hard disc), Packaging and shielding parts etc.

Integrated Circuits (IC)

An integrated circuit is made of silicon, gold, silver, copper, zinc, aluminum or their alloys are used for various purposes such as connecting leads, bumps etc. Connectors are for electrical contact between the different active elements on the silicon wafer.

Printed Circuit Board (PCB):

PCB is a macro-electronic structure compared to an IC, where a number of electronic parts are integrated (including ICs) on a fiber glass epoxy polymer with interconnecting lines.

II. Materials and Method

Collection of electronic components

Electronic components such as PCB, ICs, capacitors, connectors, transistors etc. were obtained from service centers of computers, mobile phone, telephone, television and electrical appliances situated in Gorakhpur city.

III. Results and Discussion

The failure of electronic devices due to corrosion problems and their causes in different components were identified on the basis of physical observation and micro graphical studies. Various types of problems are shown in following figures.

Corrosion in PCB

Figures 1-4 showed the micrographs of printed circuit boards of various electronic devices. Figures 1-3 are the peculiar PCB of a TV and a CFL. The solder joints are clearly shown reddish-brown indicating some type of deposition. For soldering tin or lead or a combination of both are generally used. The brown deposition is caused by high heat during the process. Tin and lead both get oxidized at soldering part. After depletion of metallic tin, the oxides may react with atmospheric contaminants like chloride and sulfates to form low solids as fluxes. Fretting corrosion is caused by Sn and SnO flaking at the solder joints [3, 4]. In sulfur bearing environment creep corrosion occurs on PCB [5, 6]. Integrated circuit (IC) failure takes place when high current transfer exceeds the maximum rating of the fabrication process [7].

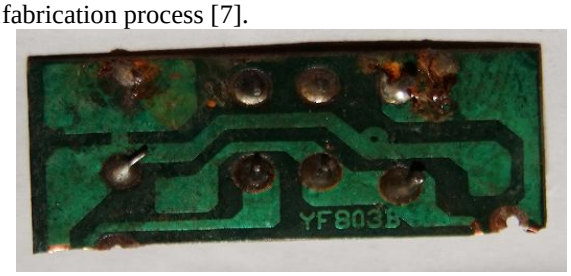

Figure 1. Photomicrograph of a PCB of television

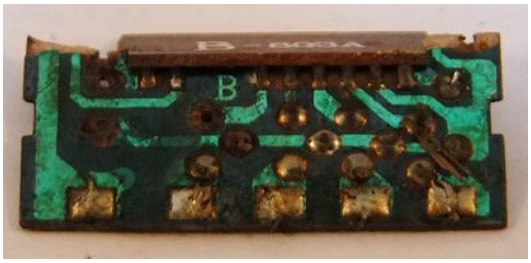

Figure 2. Photomicrograph of a PCB of TV

Figure 3. Photomicrograph of a PCB of CFL

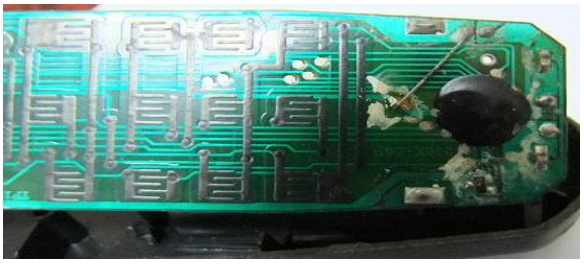

Figure 4. Photomicrograph of a PCB of remote control of TV.

Figure 4 showed the PCB of a remote control of TV where a white fluffy precipitation was found surrounding the soldering. Such deposition is termed as dendrites. As Printed circuit boards can suffer from variety of problems if the surface is contaminated with electrically conducting materials. When combined with moisture, contamination results in lowering of resistance between tracks and pads that can lead to corrosion of metals. The higher the humidity, the thicker is their moisture layer and faster the corrosion or dendrite growth. It is a type of electromagnetic migration caused by surface roughness.

Figure 5.Corrosion near a capacitor of remote control

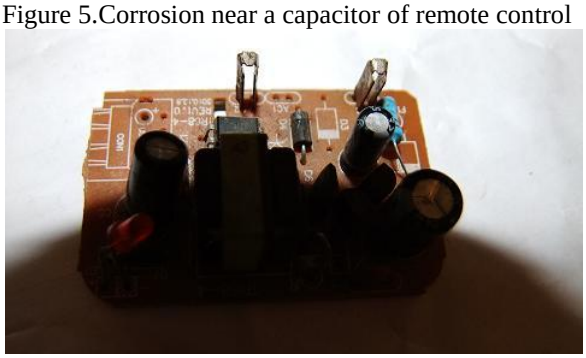

Figure 9. Corrosion at joints

Figure 10. Corrosion at joints

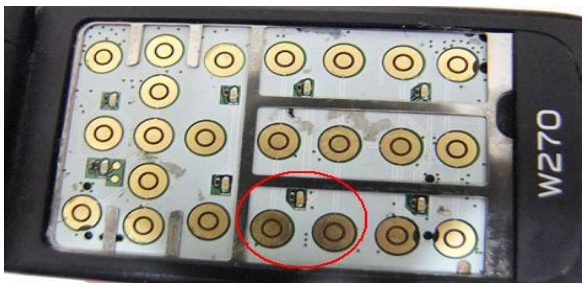

Figure 11. photograph of a key pad of cell phone

Figure 11 showed a non operating key pad of a cell phone due to layer formation at the key nodes.

IV. Development of Sensors for Corrosion Monitoring

It is very important to detect the corrosion induced initiation of damage process which subsequently proceeds to system failure. Monitoring

of corrosion is an essential aspect of safety and service life of equipments and structures. The development of electronic sensors for wide range of detection of component failure has become the prime requirement of modern technology. Various types of sensors have already been developed which are fiber optics distributed corrosion sensor, wireless sensor network, magneto resistive sensor, anode ladder system sensor, Piezoelectric Wafer Active Sensors etc [8-12].

The paper describes the design of a sensor interface proposed as future plan.

It is based on micro controller and modular software which includes: a sensor carrier board (SCB) on which all the sensing components are mounted and a sensor interface circuit (SCI) board. The sensor on SCB consists of two electrode ECS (electrochemical sensors), two electrode TOW (time of wetness sensor) and temperature & humidity sensor.

V. Fabrication of sensor

Electrochemical Sensor (ECS)

There are two electrodes in this sensor. It is made up of thin metal foil of the same alloy as that of material to be monitored.

TOW Sensor

TOW is a two-electrode inter-digital electrode sensor, where copper electrode is coated with gold. It is fabricated in an array of several units.

Temperature & Humidity Sensor

It uses digital serial interface and software to control input and output ports of micro controller to generate clock signals required for sensors.

Working Principle

The proposed sensor would be operating on the measurement of potential-current adjustment. With the passage of time a set of voltage and current readings would be collected. Through the graphical calculations resistance of sensor can be calculated. By measuring the resistance of TOW sensor the metal deterioration rate can be calculated.

Usefulness of the Sensor

The sensor proposed is capable of estimating the humidity, formation of any nonmetallic layer on the metal interface, paint or coating degradation and loss in metal substrate of any equipment or structure.

VI. Conclusions

Electronic components consist of variety of metallic objects where two or more metals are in combination that forms a galvanic cell. Accumulation of dust particles, gases, other atmospheric contaminants along with moisture at the components of electronic devices caused severe damage to the system. The corrosion of such parts decreased the service life of the equipment beyond expectation. Formation of scales and deposition of oxide residues in form of dendrites break the operation of the system.

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