Chapter 8

Microcorrosion Analysis and Their Effect in the Operation of Industrial Equipment of the Electronics Industry of Mexicali

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1. Introduction

The activities in the industrial electronic have been of great interest since the 1950 to the present days. These operations have been more important from the end of the Second World War (Lopez B. G. et al, 2007). Scientific research in MED in the design and the manufacture with more intensity revolutionized this area with the developing of great quantity of studies to improve these microelectronic components and systems used and fabricated in industrial plants and other activities (Lopez Badilla G., 2008). These investigations developed new devices such as the transistor in 1957, the microchip integrated circuits in 1966, that have been used since that time in the micro integrated control devices (MICD). These components led the develop of computer systems in 1970, the Scanning Electron Microscopy (SEM) in 1977 and some measuring instruments such as the oscilloscope in 1978 that are utilized in companies, in the researching and manufacturing process and scholar laboratories of electronic engineering (G. López Badilla, et al, 2013). Today, the MED are used in various industrial processes that manufacture microsystems, and these makes other different functions of industrial operations in the agricultural, medical, aerospace and space (Lopez G. et al, 2010). Some microelectronic devices are utilized as supply electrical power, control, indication, separation and organization in the manufacturing processes. Sometimes, for environmental factors as air pollution and climatic parameters as relative humidity (RH) and temperature, generates electrical failures originated by the corrosion process, causing economic losses by low yielding of the industrial equipments and machinery with MED. Corrosion in microelectronic devices is known as microcorrosion and is not detected at naked eye in the manufacturing processes, until the MED fails and causes uncontrolled situations in industrial plants, and preoccupy to specialized personnel, managers and owners. The microcorrosion is observed only by the SEM technique and other micro and nano procedures (Gustavo López B. et al, 2013). The indoor pollution generated by variations of climatic factors and CL of chemical agents from the outdoor sources, originated aggressive environments and the deterioration of materials very fast. For this reason, the MED are manufactured according to their functionality and corrosion resistance. At present, the materials used in the electronics industry in the world, are: aluminum, copper, chromium, tin, nickel, gold, palladium, platinum, silver, titanium, tungsten and copper alloys, tin-silver-palladium (Bella, 2002).

2. Electronics industry

The electronics industry has grown tremendously, and have a lot relation with other industries, increasing gradually in the developing countries, with a wide variety of electronics manufacturing equipments, which are used frequently (Lopez B. G, et al, 2010). In Mexico, there are a lot industrial parks with national and foreign companies located in the most important cities as Mexico City, Guadalajara, Monterrey and bordering cities of the United States (USA), as Ciudad Juarez, Mexicali, Nogales, Reynosa and Tijuana. In Mexicali, a report by the Industry Association of Mexicali (IAM, Asociación de Maquiladoras de Mexicali (AMAQ), in Spanish)-(AMAQ, 2012) indicated in 2010, the location of 150 industrial plants installed, being 100 of the electronics industry.

3. Design of electronic equipment

Sometimes, microelectronic devices with metallic materials from suppliers are affected by corrosion in the transportation process, in the reception of materials and in the storage of these MED (Lopez Badilla G. et al, 2011). Personal of warehouse of the electronics industry report some MED deteriorated each week of the year in this region of Mexico. Sometimes are reported the cases when it fails in the manufacturing processes or with the users, and is necessary pay the warranty generating economic losses (G. López-Badilla, et al, 2013). Factors as concentration levels of sulfurs mainly formed by the presence of hydrogen sulfide (H2S) and sulfurs oxide (SOX) that exceed the AQS principally in the winter season, and the variations of RH and temperature, promotes the formation of aggressive environments in indoors of the electronics industry and originates very fast the corrosive phenomena in this city, that deteriorate the MED very fast (G. L. Badilla et al, 2013). Corrosion in metallic materials used in the electronics industry are similar for other materials, but with two differences: being the first the applied voltage (105 to 106 V / cm), causing deterioration in the majority of MED by the uncontrolled flow current between conductors and ionic impurities (ASHRAE, 1999). The second difference is the size of components that are sometimes microns and require very low concentrations of pollution and film moisture to generate corrosion (Tahara A. et al, 2005). This cause electrical failures of any microelectronic device in short periods. Some electrical failures in these types of components have been reported by the migration of ions released during the formation of corrosive agents as metal oxidation, reducing to the cathodic process and generating dendrites (Lopez Badilla G. et al, 2013). This originates conductivity between the electrodes, allowing the growth of whiskers (being a detachment of metals) principally in cadmium, tin, gold, silver, zinc and copper-nickel alloy. Corrosion in welds is also considered important because it causes lack of adequate adhesion of the MED in the electronic boards (Gustavo López-Badilla, et al, 2013).

4. Industrial operations in the electronics industry

Technological advances in the electronics industry require increasingly smaller devices as the MED, with more components in their encapsulated and with major quantity of functions (Lopez Badilla G., 2008). The Micro Metal Oxide Semiconductor Field Effect Transistor (MMOSFET) and the Micro Bipolar Junction Transistor (MBJT), which are the most important basic electronic components in the electronic devices and systems, are developed as a special semiconductor with smaller dimensions than 0.1 microns (G. López-Badilla, et al, 2013). The number of functions of the MED depends on the amount of components increasing their operation capacity. The silicon semiconductor structure protects the internal elements of variations of RH and temperature, external connections to the chip and can dissipate the heat generated internally. A great advantage of use a material as copper in the MED is for their low cost and good electrical and thermic properties (G. López Badilla, et al, 2013), but is very susceptible to the corrosion phenomena. (Abdulaziz, 2003). The electronics industry which is located in the Mexicali city, have a wide variety of MED in the industrial equipments and machinery, and sometimes in indoors of these companies, are exposed to uncontrolled environments, generating the fast deterioration of electrical connections of the MED. In the manufacture of electronic devices and systems that is performed in the electronics industry, are presented four main steps, as mention in the figure 1. These stages are: (a) storage area, where are collected materials for the production process, (b) manufacturing zone, where is transformed the raw material, (c) inspection area where is evaluated the quality of products and (d) shipping zone where is installed the final product to send to customers Lopez B. G. et al, 2007).

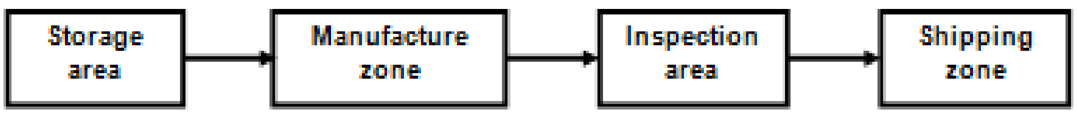

Figure 1. Steps of the manufacturing process in the electronics industry

5. Atmospheric corrosion in the electronics industry

Atmospheric corrosion is an electrochemical phenomenon generated by a wet film formed on the metallic surfaces of metals as copper used in the MED, where sometimes is visible and in other is invisible (Gustavo L. Badilla et al, 2013). This film is the electrolyte where the metal is dissolved, generating the metal ions movement, which promotes the corrosion phenomenon. The corrosion products forms dendrites and whiskers on the connections and joints of microelectronic equipment connectors. A feature of the electronic components is its design that avoids the accumulation of water, by variations of moisture. These are important factors in the formation of the electrolyte layer which cover the metal (Cerrud-Sánchez. S.M et al, 2005). The film formed on the metal surface of metals used in the MED utilized in indoors of the electronics industry, is thinner than the film formed in metals exposed at outdoor conditions. It requires a very precise analysis to detect the electrochemical process, indicating that the corrosion in indoor environments is different type that in the outdoor zones. This mean that the analysts of corrosion, specialized methods to detect the corrosion phenomena in metallic materials used in microelectronic devices and systems, with greater capacity and at micro scale to detection the corrosion, to reduce and control this electrochemical process. Air pollutants with more aggressiveness are the H2S and SO2 emitted from the principal outdoor source near of the Mexicali city, called the Cerro Prieto geothermal field, located at 25 km of this city, and these chemical agents are emitted and dispersed to the Mexicali city. The geothermic plant provides of electricity to the Mexicali city, their valley and some bordering cities of USA. The exposition of these chemical agents causes some tarnishing in the metals of MED. Other outdoor sources with a minimum effect are the traffic vehicle and the oxidation ponds composed of sewage (G.-López-Badilla, et al, 2013).

6. Corrosion in the electronics industry of Mexicali

Presence of corrosion of metals used in indoors of the electronics industry in Mexicali appears as an electrochemical process involving two aspects: wet and dry climate combined with the presence of H2S and SOX mainly. This increases the corrosion rate (CR). In the period of 2009 to 2010, the electronics industry reported an increment of 40% in the electrical failures of the MED, and specialized people was concerned and have interest for a company of the electronics industry in Mexicali for the presence of corrosion (G. López et al, 2012). A industrial plant of this city allowed the realization of a researching of the fast deterioration of the MED. For this reason, the MED of electronic industrial systems and machinery metallic were evaluated in periods of 1, 3, 6, 12, 24 and 36 months in the manufacturing and warehouse areas of the company analyzed, to determine the CL and the principal causes of the corrosion phenomena. The generation of electrical failures in industrial electronic equipment, provoked defective MED, because at certain times of the year will occur more often. An analysis reported in the operational yielding, indicated that electrical failures were increased by up to 40%. This occurred principally in the months from July to August of 2008 when the RH and temperature were higher than 75% and 40 °C, and from December of 2009 to January of 2010, and when the

RH and temperature were near of 90% and 15 °C. From December of 2009 to February of 2010, was showed the greenhouse effect where air pollutants are not dispersed easily. This information supports the hypothesis of the climatic and pollution conditions that were the principal parameters of the generation of corrosion in the electronics industry of Mexicali (Gustavo López B. et al, 2013).The topography of this city and the winds, which originates the dispersion of the air pollutants were other factors of the presence of this electrochemical phenomenon. Certain pollutants in an area of the city and its valley, reach other zones and in some times with lower levels are generated the aggressive environments and the corrosion process. It is for this reason that this research was developed to evaluate the indoor atmospheric corrosion in a company and the correlation with the production yielding of the industrial equipment and machinery. Besides the air pollutants mentioned which influence the corrosion process, there are other small particles that cause the formation of corrosive agents as microorganisms (Leidecker, 2006). Analysts of microcorrosion, mention that the absorption method is the best technique to evaluate the corrosion products of copper, nickel and zinc. This indicates a strong influence of carboxylic acids and organic species, such as acetates, oxalates formats and internal emitted by anthropogenic sources as burning wood and tires, that are small aspects in the electrochemical phenomena, but generates deterioration in metallic surfaces of electronic devices (Fontana, 1986). An example of the formation of corrosive agents is shown by a study conducted in Japan with the comparison of metals of copper and tin, after three months of exposure to sulfate occurred in the electronic industry of Mexicali is showed next in Figure 2.

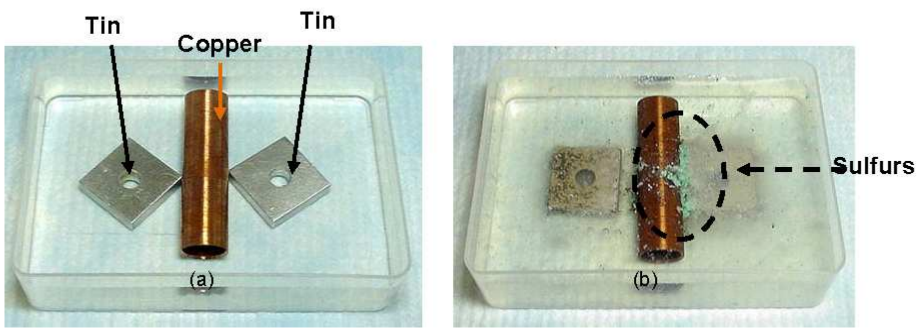

Figure 2. Analysis of copper metal: (a) before and (b) after the corrosion process

7. Description of the project

This research project was performed to determine the corrosive effect of air pollutants that adhere to the joints and connections of the MED used in the electronics industry of Mexicali. The main objective is know the kinetic of the corrosion phenomenon generated in the metallic materials of the MED and establishes the prevention and control of corrosion. With the information obtained from this study, was indicated the CL in deterioration of the MED obtained of the evaluations in indoor of the electronics industry, as based on the presence of atmospheric and climatic parameters. The analysis was made with the specifications of ASTM standards, and was determined the CL. This analysis simulates the deterioration of electrical connections of the MED in harsh environments with the presence of sulfates combined with the variations of RH and temperature. Extreme climatic conditions of outdoors of the electronics industry sometimes are uncontrollable in the indoor areas of industrial plants installed in Mexicali. The corrosion process was promoted very easy with values higher than 75% and 30 °C, that are very common in the majorly of the periods of the year in Mexicali. This promotes the electrochemical phenomena and forms small and big spots in the metallic surfaces of the MED. To control this problematic situation, it was necessary to use techniques and methods of protection, such as corrosion inhibitors and surface treatments (Ponchak, 2004).

8. Comparative studies of microcorrosion

Several studies mention about the effect of microcorrosion generation in the operation yielding of microdevices used in the electronics industry. This process of analysis indicates that at the minimum presence of corrosion in these electronic components, generates a significant impact on the deterioration of electronic microdevices. Below, shows a descriptive analysis of some studies in various areas of the world in Table 1.

Authors	Title	General aspects	Effects of microcorrosion
Gustavo Lopez Badilla, Benjamin Valdez Salas, Michael Schorr Wiener and Carlos Raúl Navarro González	Microscopy and spectroscopy Analysis of MEMS corrosion used in the electronics Industry of the Baja California Region, Mexico	Analysis of mcirocorrosion and their effect in the fabrication of MEMS	Generation of electrical failures in MEMS used in the electronics industry
Gustavo López-Badilla Catalina González-Hernández Antonio Valdez-Ceballos	Análisis de corrosión en MEMS de la industria electrónica en ambientes árido y marino del noroeste de México	Generation of aggressive environments in indoor of industrial plants caused by: - Air pollutants as sulfurs in arid zones and chlorides in marine regions. - Variations of climatic factors as relative humidity and temperature	Low productive yielding, originating economic losses in the economy of this region with deteriorated material, rework, defective products, warranty
Pouponneau P, Savadogo O, Napporn T, Yahia L, Martel S	Corrosion study of single crystal Ni-Mn-Ga alloy and Tb0.27Dy0.73Fe1.95 alloy for the design of new medical microdevices	Analysis of the deterioration of alloys of smart magnetic materials used in the medical activities y the corrosion process	Origination of electrical failures in medical microdevices, caused economic losses by the defective of microcomponents

Table 1. Comparative analyses of microcorrosion

9. Methodology

Water exists in the atmosphere as liquid phase, steam and solid. Moisture levels depend on the steam pressure which exists in a particular environment. The RH and temperature were the most important climatic factors in this study, which promoted the increase very fast the CR. The information of air pollutants, temperature and RH by periods daily, weekly, monthly, seasonally and at the year, was obtained and organized by the EMS (Environmental Monitoring Systems) for the project of the border cities of Mexico and USA installed for the Environmental Protection Agency (EPA) (NAAQS, 2012) in according with the Secretaria de Medio Ambiente y Recursos Naturales (SEMARNAT of Mexico). The proposed methodology used was according to the standards of ASTM (G4) (ASTM, 2001), and the study was made from June of 2009 to August of 2012 with the experimental procedures in indoors of the electronics industry to determine the CL with the ISO 9223 for the CL (ISO/CD 11844-1, 2001, ISO 9223, 1992).

10. Statistical information

The pollutants H2S, SO2, NOX O3 and CO detected by the EMS in the outdoor environments Mexicali, which penetrate at indoors of the electronics industry. This mixture of air pollutants, together with variations in moisture and temperature, rises the CR of MED used in the electronic equipment. For the correlation analysis data were used periods where the RH and temperature were above 70% and 35 ° C, and the concentrations of air pollutants mentioned above that overpass the levels of AQS. The information obtained was organized in tables with the corrosion of metallic surfaces of the MED analyzed to determine the degree of correlation between climatic parameters, contamination and corrosion.

11. Environmental monitoring

The air pollutant data was obtained with specialized equipment containing data acquisition systems specialized and organized on a monthly, controlled by the EPA. The measuring instruments techniques are the chemiluminescence analyzer model 42 to the H2S, the Thermo Environmental Instruments Inc. to detect NOX, 300E model with a filter API (Advanced Pollution Instruments Inc.) for CO, the model photometric analyzer of Thermo Electron Corporation 43C for SO2 and model 400 detectors API for O3. These instruments have special filters to detect gases and particles (Annex A. Mechanisms of measurement).

12. Scanning electron microscopy (SEM) technique

This technique was used to determine the chemical elements from compounds which react with the metallic surfaces of the MED analyzed. The electrons flowing through the low energy generated by the instrument topography showed electrical connections of the MED corroded, indicating the particle analysis, detection of defective MED and the metallurgical defects. With this technique, were determined the chemical composition observed in a spatial distribution of metallic surfaces of MED damaged. This was made in order to know which of the pollutants reacts in the metals to know the chemical agent with major influence in the generation of the corrosion process. A distinction was made between the different possible compounds for the oxidation state of the metal ions involved in the corrosion products. This allowed observe the morphology of corrosion products on the surface depending on the elemental composition. This technique is known in detail, quickly and accurately, to determine the structural form and location of corrosive agents, with which we determined the type of corrosion (uniform and pitting, which are the more common presented in the electronics industry of Mexicali), to suggest the best possible methods and techniques protection for metallic materials of the MED.

13. Results

The origin of corrosion in indoors of the electronics industry was due to variations of the climatic factors that were mentioned above and combined with the presence of sulfurs principally in the Mexicali city. In the winter season, appeared uniform corrosion by the wetting film formed on the metallic surfaces of the MED, and in the summer period, was generated the pitting corrosion in these materials by the occurrence of some droplets that adhere to certain areas of the metal surface. This is partly was due to the wetting time (also called time of wetness (TOW), which is an important factor of the origination of the corrosion phenomena). The TOW was obtained with the evaluation of RH and temperatures above 75% and 35 °C that is common in the city analyzed in the majorly of periods of the year.

14. Evaluation of climatic factors

In this study, the corrosion process initiated in indoor atmospheres of the electronics industry of Mexicali city, influenced by external climatic conditions (Gustavo L. Badilla et al, 2013). The wetting time obtained with the RH and temperature of the city of Mexicali, shows high rates in some winter and summer periods, being an important factor for the type of corrosion that occurs in metals used in the MED of industrial plants, and the levels at which the CR increases. In this process are formed some voltage electrodes, for example in the binding of copper to tin the voltage was 0.2 volts, and caused an electrical malfunction. The minimum wetting time in the winter period was presented in December with a value of 58 cycles and the maximum peak was in February with 163 cycles. This occurred with a temperature range in outdoor environments from 4 ∘C to 24 ∘C, resulting in a negative effect in the indoors environments of the electronics industry. In the summer period from July to August of 2012 the RH is greater than 75%, and temperatures above 35 ∘C, and some droplets were formed in some areas of the metal surface, generating selective corrosion of metal parts, being mainly pitting corrosion. In change, in the winter seasons from December of 2011 to January of 2012 with indices of RH and temperature higher than 90% and lower than 20 °C, occurred the formation of the wetting film in the entire metallic surface presenting the uniform corrosion. The wetting time in the summer period of 2011 was 47 cycles as the minimum level presented in June and the maximum was 135 cycles in August. This factor was very essential to know the kinetics of corrosion in MED, being with major effect in summer than in winter by the presence of pitting corrosion.

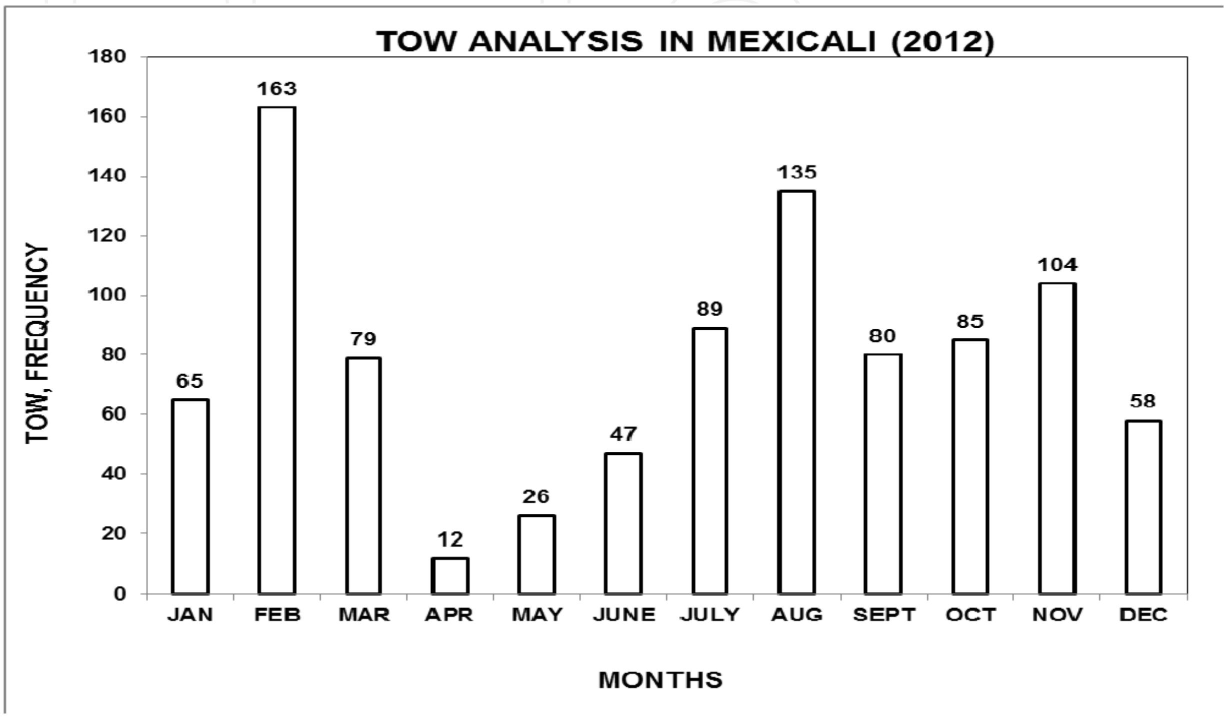

Figure 3. Analysis of TOW in Mexicali by monthly periods (2012)

The TOW influenced in the velocity of deterioration of MED presented a CR higher in the summer periods than in winter seasons due to the effect of temperature (greater than 35 ∘C) that is showed in figure 3. The design of electronic components and equipment, such as size, structure and characteristics of the metal surface is essential to prevent the corrosion phenomena. At the beginning of the analysis period was less the TOW, in the summer month with 0.22, but increases from 3AM and 9AM to its maximum value of 0.57 and started down to get close to 0 from 24:00 to 6PM. In February, there were initial values of 1:00 a.m. to 3:00 a.m. 0.25 and maximum of 0.38 at 5AM where it remained and began a descent from 8AM and stay between 0.1 and 0.2 and increases again from 8PM to a value close to 0.3. These cycles of wetting time indicated the duration of the corrosion process in metals generated electronic equipment and the formation of corrosive agents in connections and electrical connectors. The influence of cold air causes the temperature in a metal surface, decreased below the dew point, with the RH levels higher than 80% and was formed on the metal film. This occurred in Mexicali in the period of the study, causing corrosion, which depended on the size, orientation and surface characteristics where the phenomenon caused. With the ISO 9223 standard, levels were determined the wetting time, with the lowest effect T1 and T5 that a major factor in the deterioration of metals used in the electronics industry. In this city, even if the wetting time has levels from T1 to T3 (in annual period), and T1 and T2 in February, August and November, corrosion is generated by regional climatic variations. The annual analysis shows the hours where there were peaks of TH 5AM being at 7AM and in this period were additionally obtained the hourly averages, standard deviation and minimum, to know in more detail the process of film formation on surfaces metallic materials evaluated (Table 2).

Parameters	Peak Hours at Monthly periods	Peak Monthly Periods			Annual
	5, 6, 7AM (Fcia.)	February	August	November	
Average	8 , 9, 7 (T1)	7 (T10	6 (T1)	4 (T1)	63 (T2)
Standard Deviation	4, 5 , 5 (T1)	3.1 (T1)	6.2 (T1)	3.3 (T1)	38.7(T2)
Minima	1, 1, 0 (T1)	3 (T1)	0 (T1)	1 (T1)	27 (T2)
Maxima	15, 17, 17 (T2)	12 (T2)	17(T2)	10 (T2)	134 (T2)
Total	399 (T3)	163 (T2)	135 (T2)	104 (T2)	1504 (T3)

Table 2. Evaluation of TOW by monthly and annual periods in according to ISO 9223

This evaluation was performed for the periods in which need have better control of indoor climate controlled the industrial plants of this city.

15. Analysis of environmental pollution

Data of air pollutants obtained by the EMS showed interesting information to determine the principal chemical agent in the deterioration of the MED. In this section of the study, were evaluated only the pollutants with the different ranges of the NO2, O3 and SO2, and not analyzing the CO for their ranges greater than the by monthly periods. The analysis was made at the times of this chemical agents overpassed the AQS in daily periods representing in percentages days of the 2012 as showed in figure 4. Higher levels present the SO2, NO2 and follows after O3 in 2012 year where the values increased to almost 56 % of times overpassed the AQS for SO2, as the maximum level in January and December and the minimum indices was 8 in July. For NO2, the maximum index with 34 was in January and the minimum level was 4 in July. And to the O3, were 28 in January as the maximum level and 2 in July as the minimum index. The air pollution periods varies in different hourly, daily, weekly, monthly and yearly periods, after by the traffic vehicle and industrial plants mainly, which originates the formation of greenhouse effect principally in the winter season and the dispersion of pollutants in the Mexicali city depending the wind direction and speed. The indoor atmospheric corrosion of the electronics industry has been controlled but not eliminated in cleanrooms, and sometimes metals like copper have spots that indicate the onset of corrosion. The atmospheric corrosion in indoor environments is reduced when they controlled microclimates,

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which increases the performance of electronic equipment. The environments without climate control, the corrosion rate increases rapidly, damaging metallic materials. The deterioration of metals in February was lower than in August as temperatures above 35 ∘C. In winter SO2 concentrations have a large effect on the poor productive yielding of the MED and thus industrial systems and machinery. It was easily dispersed into the atmosphere and easily adheres to metals, but the corrosion process is slow. The correlation of SO2 at low levels of RH and temperature deteriorates the MED too, mainly in the months of February and August. An analysis of the CR according to the formation of corrosive agents in joints and connections was made, and were higher in August than in February, as a result of higher temperature ranges. In winter we evaluated the wet film formation and corrosive metals and concentration indices of air pollutants.

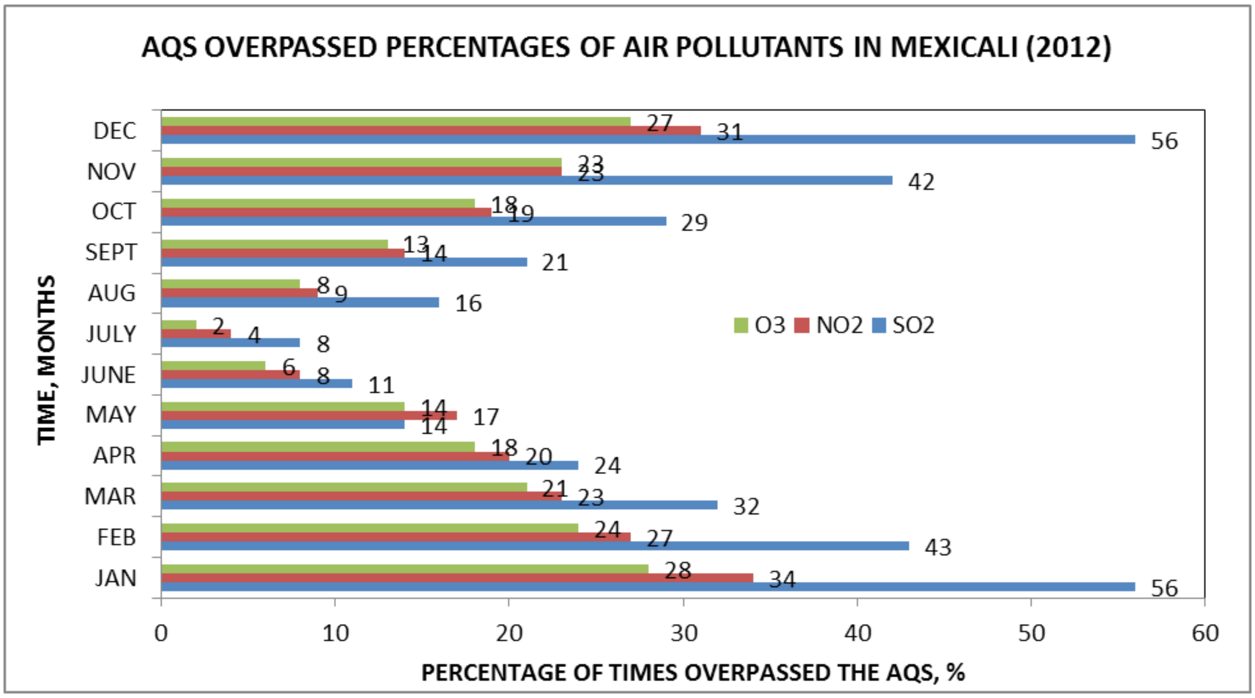

Figure 4. Analysis of TOW in Mexicali by monthly periods (2012)

16. SEM evaluation

The SEM analysis shows the grade of deterioration in the MED electrical connections of the MED. The microphotographs were obtained of the microelectronic devices damaged. An evaluation indicates at least 10 electrical failures at week of the MED as was observed in figures 5 and 6. At macro levels are not observed the deterioration of the materials, but in the SEM analysis were showed the great effect of the corrosion process. To detect very fast the corrosion phenomena, was necessary considering always the use of microanalysis with the SEM technique. Figure 5 shows some MED damaged by corrosion at 500X and after was made an evaluation at 5X to detect with better precision the deterioration of the MED corroded in the spring and summer periods of 2012. At 5X, was observed the formation of the uniform corrosion in spring in the majorly if the metallic surfaces of electrical connectors and connections of the MED. This was promoted by variations of the RH principally. In change in the summer season indicates the presence of in a small section of the metallic surfaces the presence of uniform corrosion and tending to appear the pitting corrosion, being an important factor for it the high levels of temperature.

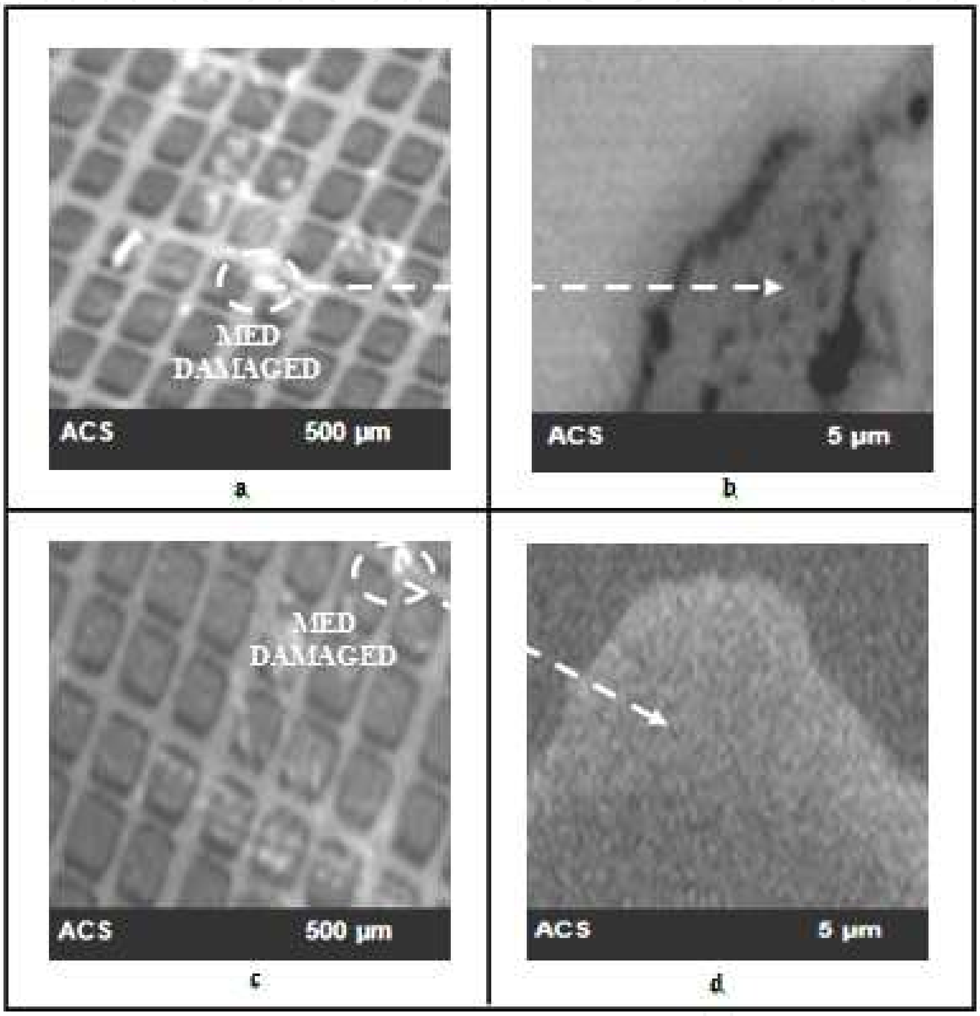

Figure 5. SEM analysis the deterioration of MED in spring at (a) 500 X and (b) 5 X and in summer at (c) 500 X and (d) 5 X in the electronics of Mexicali (2012)

In Figure 6, are showed the analysis of the autumn and winter periods, indicating in the autumn season, a great deterioration represented by the black sections, promoted by the levels higher than 80% of the RH. In the winter period, the appearance of uniform corrosion in the majorly of the metallic surfaces, indicated a similar deterioration as in the spring season by the variations of RH. This shows the kinetic of the corrosion process in different season of 2012 and the mechanisms that promote this electrochemical phenomenon.

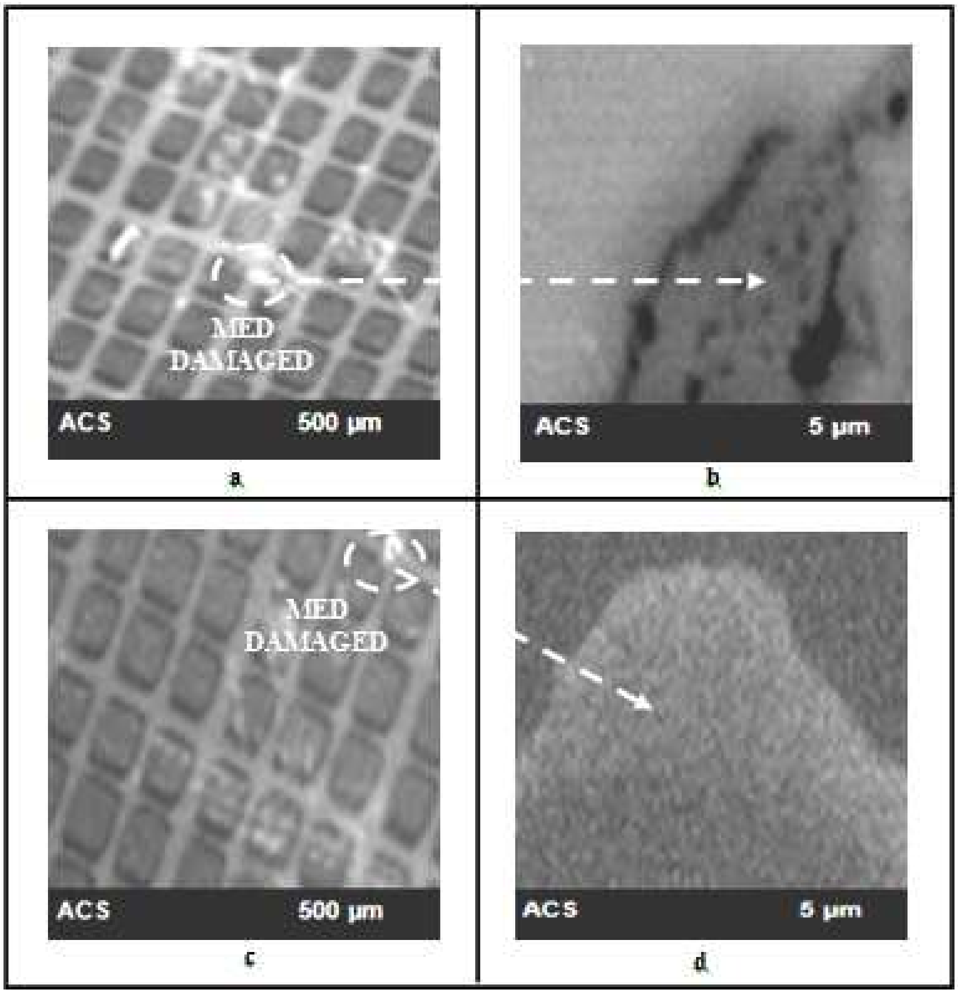

Figure 6. SEM analysis the deterioration of MED in spring at (a) 500 X and (b) 5 X and in summer at (c) 500 X and (d) 5 X in the electronics of Mexicali (2012)

The importance of analyzes the phenomenon of corrosion in metallic materials used in the electronics industry in Mexicali, is to assess the negative effects of corrosivity levels in the indoors of the electronics industry in Mexicali city. The metals used in the MED electrical connections were constituted of copper, gold, silver and tin mainly.

17. Conclusions

The presence of corrosion in the MED caused the low productive yielding in industrial equipments and machinery. The mathematical correlation was made from the information obtained of the pollutants that was adhered to the metallic surfaces. The chemical agents were emitted from outdoor sources and penetrate to the indoor environments, through holes, cracks or air conditioning flow. The uncontrolled climate parameters as humidity and temperature, promoted the formation of a wet film on metal surfaces, generated by the corrosion process. The deterioration of materials generated bad function in the microelectronic devices due to inappropriate conductive paths (dendrites) formed between connections unnecessary electrical connections. The dendrites formation was due to migration of metal ions released by the etching process, which presents a voltage caused by corrosion current as a flow between conductors in the presence of mobile ionic impurities. Thus, electrical currents are generated in the order of micro amperes components alter their function by electrical failures and reducing its operational performance. Most components require specific values of current and voltage for operation, or they stop working. The corrosion phenomena observed in various metallic materials used in the electronics industry was similar in some phases, as was indicated by other studies. However the metals that constitute the MED showed different types of corrosion at the final stage depending on the environmental conditions. Corrosion was a problematic situation in the electronics industry of Mexicali, even in clean rooms. The develop tests to detect the origin and occurrence of corrosion is difficult for the complexity of the microelectronics devices, and lack of controlled indoor climates. Climatic factors, combined with the fine particles and gases such as hydrogen sulfide, sulfur dioxide, carbon monoxide and nitrogen oxides, which sometimes exceed the air quality standards in the region, generating harsh environments in indoor of the electronics industry, causing the corrosion phenomena. One of the principal emission sources which generate aggressive atmospheres in indoor of the electronics industry of this city was the geothermic plant that supplies electricity to Mexicali city and their valley and some cities of United States. Other minimum emission sources are the traffic vehicle, industrial plants, soil erosions and microorganisms. These pollutant particles adhere to the metal surfaces with or without the film formed by climatic variations and start the corrosion process. Also, with levels greater than 80% humidity and 25 ∘C that is common in the Mexicali city was obtained the TOW cycles, which indicates the periods in which a metal surface remains wet enough to give way to a process electrochemical corrosion to occur.

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