CHAPTER II
LITERATURE REVIEW

2.1 Smart Cards

Smart cards (also called chip or integrated circuit cards or ICCs) are small card that contains a microprocessor chip. They are normally in the shape of a credit card. Smart cards are two basic categories of the integrated circuit cards; contact smart card and contactless smart card.

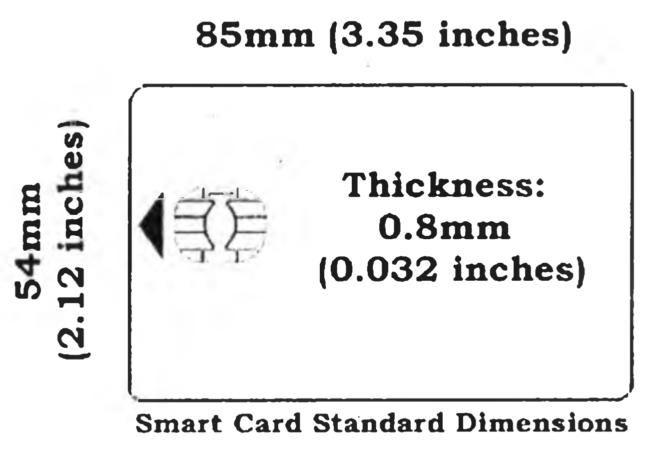


Figure 2.1 Examples of smart card standard.

2.1.1 Contact Smart Card

The contact smart card (which requires a card reader) has a set of gold- plated electrical contacts embedded in the surface of the plastic on one side. It is operated by inserting the card into a slot in a card reader which has electrical contacts that connect to the contacts on the card face thus establishing a direct connection to a conductive micromodule on the surface of the card. The application of card is traditionally used at the retail point of sale or in the banking environment or as the GSM SIM card in the mobile phone.

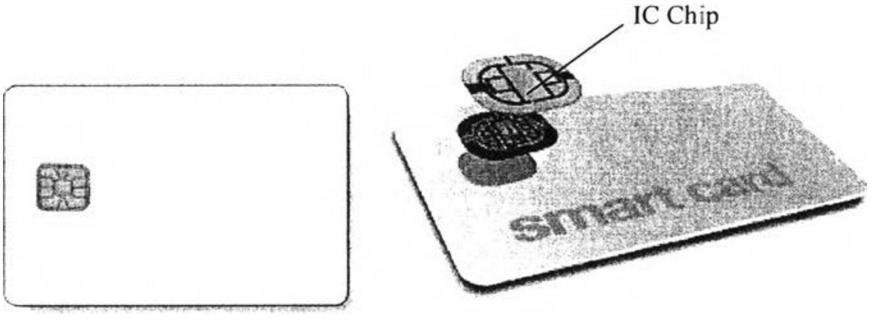


Figure 2.2 Examples of contact smart card.

2.1.2 Contactless Smart Card

Another type of smart card is a contactless smart card. A contactless smart card (which use radio frequency signals to operate) looks just like a plastic "credit card" with a computer chip and an antenna coil embedded within the card. Most contactless cards also derive the internal chip power source from this electromagnetic signal. Radio frequency technology is used to transmit power from the reader to the card.

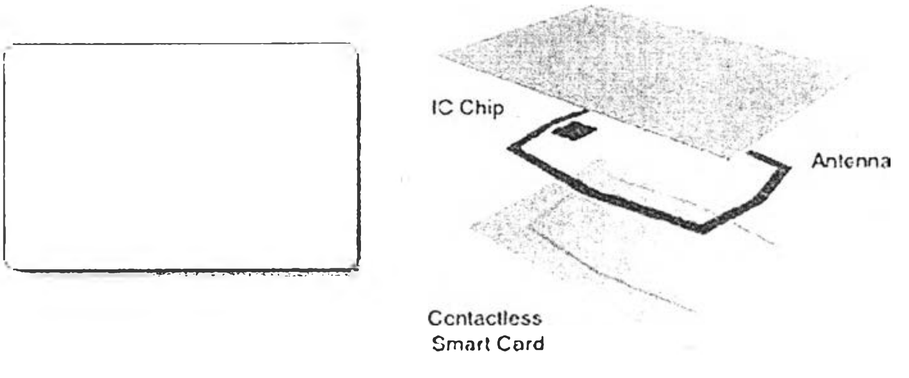


Figure 2.3 Examples of contactless smart card.

2.2 Plastic Smart Cards

There are several types of plastic use for smart cards. Plastic can be divided in many types which depended on the application. Therefore, there are many classical materials which widely used for smart card. The main types are PVC, PC and PET.

2.2.1 Polyvinyl Chloride Smart Card

PVC is the least expensive of the main card body materials. It is used for both contact and contactless cards, but generally has a shorter life expectancy than other card body materials, due to a lower resistance to heat, UV and bending stress, which can cause premature delamination and module separation. PVC is generally used for financial cards with a life expectancy of 3-5 years. The main durability issues of PVC include: surface wear (scratching and print erosion), de-lamination where finishing layers begin to separate, effects of physical stress (flexing and twisting) on the card body, chemical damage (from petrol, nail varnish, cooking oil, etc.), UV light causing print finish deterioration, and weaknesses caused by certain personalization features (embossing, laser engraving.

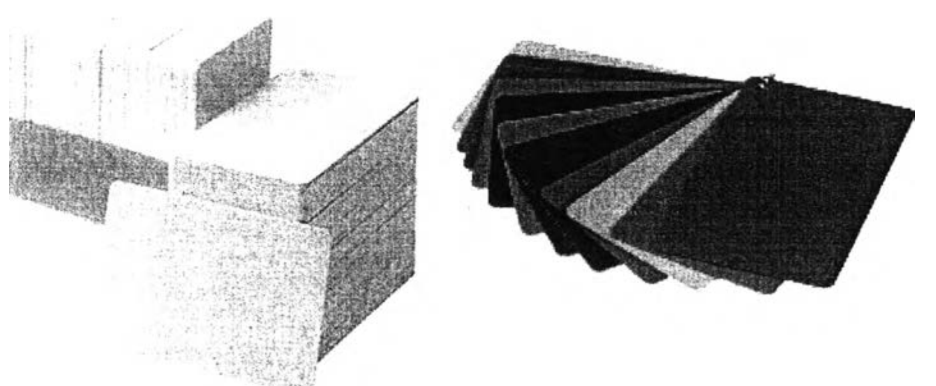


Figure 2.4 Examples of polyvinyl chloride cards.

2.2.2 Polycarbonate Smart Card

The scientist was found the way to reduce the toxic material which replaced by polycarbonate. PC is a more rigid card body material which has a much higher resistance to damage from heat, flexing and UV. PC is used for an application which requires an extremely stable or highly durable application. However, PC can have a tendency of brittleness which can be adversely affected by frequent automated handling, causing shatter cracks and is less resistant to caustic solutions and certain solvents.

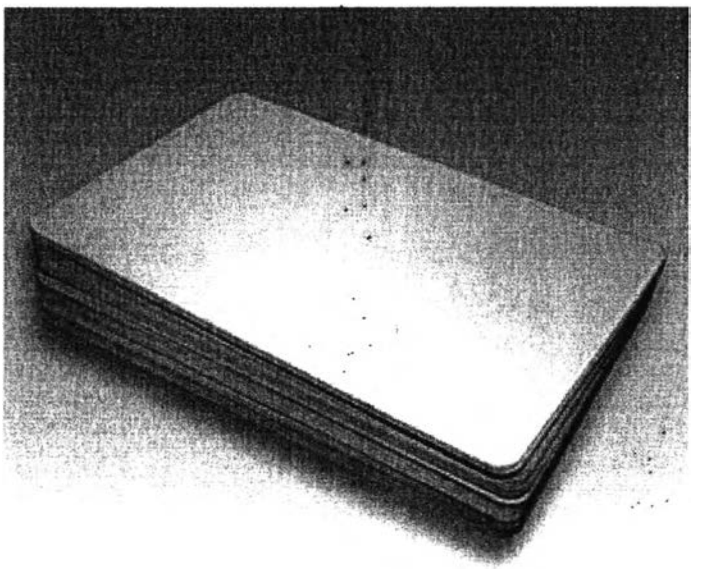


Figure 2.5 Examples of polycarbonate cards.

2.2.3 Polyester Smart Card

Another type of plastic card is polyester such as PETF and PETG. They are special materials that have been developed to enhance specific strengths or reduce certain weaknesses. These derivative materials are often combined with specialty card body substrates to significantly enhance the physical durability of cards for specific applications. In particular to reduce the incidence of antenna connection breaks and contact plate separation caused by flexing and bending of the card body.

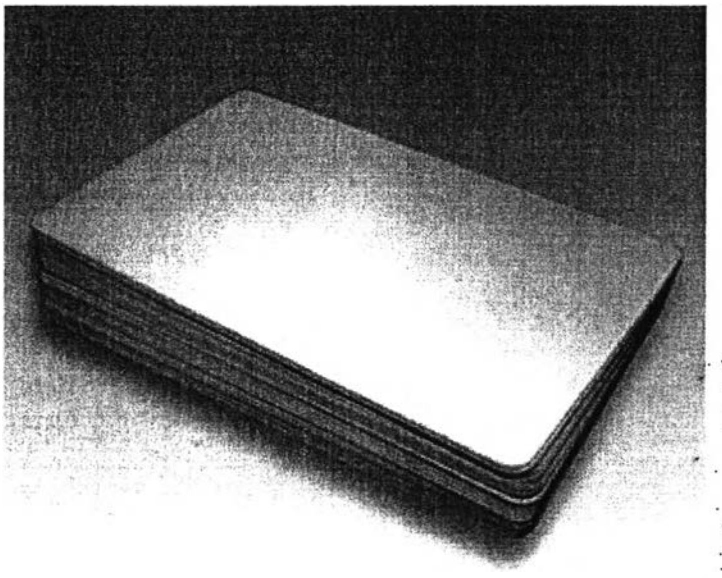


Figure 2.6 Examples of polyester cards.

2.3 International Standards Organization

The International Standards Organization (ISO) is a network of 148 countries' institutes of standards that provides consensus for decisions governing standards for various products worldwide. However, the majority of chip or smart cards used in the UK, Europe and USA confirm to the following ISO standards for magnetic cards. The smart card quality is determined by international standard ISO/IEC 10373-1 which defines the identification cards, test methods and general characteristics. Meanwhile, the scientist also used ISO/IEC 7816 which defines the physical characteristic of plastic such as flexibility, temperature tolerance and functionality. ISO/IEC 7816 is used by both contact and contactless smart card applications for security operations and commands for interchange.

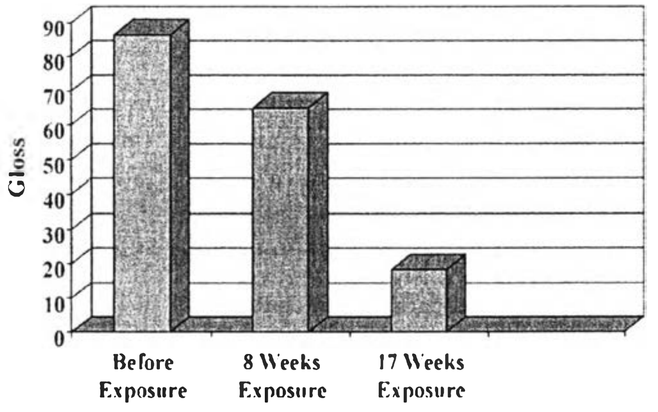
2.4 Literature Review

In a past few decades, many researchers started to define standard of smart card , applications of smart card and plastic lifetime. A great deal of work has been done to find an optimum process condition, standard and overview in order to enhance the economic feasibility and product.

Katherine M Shelfer *et al.* (2004) studied an overview of the history, commercialization, technology, standards, and current and future applications of smart cards. They also included a summary of the invention of smart cards. However, they described the physical characteristics of the smart card, and its associated contact and contactless interfaces, integrated circuit (IC) chip and processor capacity.

Emmanulle Mathieu *et al.*(1995) studied the aging of some plasticized PVC formulation used for textile coating. They had compared two weathering chambers; QUV and Weather-O-Meter. However, the degradation has been measured by the variation of the IR optical density at 1780 cm^{-1}. They reported that the WOM weathering is representative of the different form of outdoor weathering degradation with an acceleration factor of same unit, however the degradation acceleration is not as large as that obtain with QUV for samples which the latter causes an aging which is representative of reality.

At 2001, X.F. Yanga *et al.* studied the degradation of polyurethane topcoat over a chromate pigmented epoxy primer was measure by scanning electronic microscopy (SEM) and gloss measurement after the coated panels were exposed in a QUV chamber. It was found that upon QUV exposure, blisters formed on the topcoat surfaces during the initial phase of coating degradation. As a result of blister formation and subsequent breakage, coating gloss was lost before any pigments were exposed in the coating. Figure 2.7 (right) shown the coating surface cracked and pigments were exposed on the coating surface.



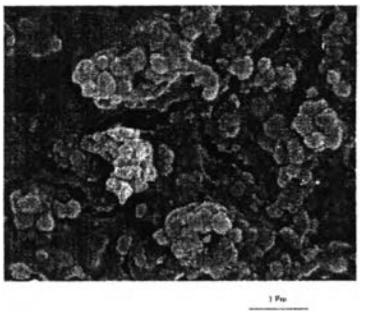


Figure 2.7 Coating gloss measurement at 60° showing the reduction of the coating gloss in the first 17 weeks of exposure (left) and SEM micrograph showing the surface after 24 weeks exposure.

G.F. Tjandraatmadja *et al.* (2002) studied the effect of weathering, and in particular UV on unsterilized polycarbonate by exposed in a QUV weathering panel chamber with UVA-340 nm. The result showed the rough polymer surface associated with the degraded layer increases the scattering of light on the polymer surface, which reduces gloss retention. The loss in gloss is associated with an increase in diffuse light scattering on the sample surface and correlates with features on the SEM micrographs.

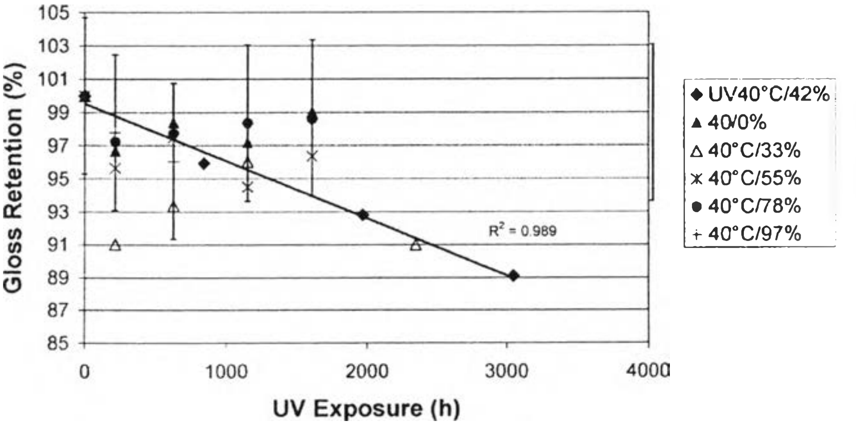


Figure 2.8 Variation in gloss of polycarbonate (relative to the gloss of the control sample) after exposure to various humidity levels with and without UV.

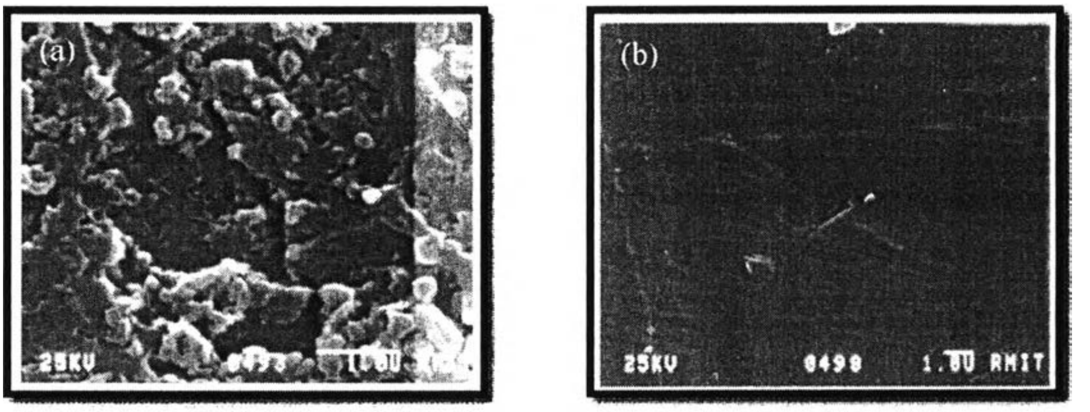


Figure 2.9 SEM of PC exposed to UV for 2350 h (a) and SEM of control PC (b).

Figure 2.9 shows SEM image of the PC surface before and after exposed. The exposed sample had a rougher appearance (Fig. 2.9a), whilst the control sample exhibited a more uniform and smooth surface (Fig. 2.9b). The rough surface associated with the light scattering which shown lower of gloss retention.

Andreia C. Tavares *et al.* (2003) studied the mechanical properties of polyethylene subjected to accelerated aging in Weathering Tester (QUV) and weatherometer (WOM) chambers. The effect on mechanical properties was measured by the nanoindentation technique. It was observed that hardness and elastic modulus values grew higher from surface to bulk with aging time and that the QUV regime exerted a more severe degradation effect than the WOM (Fig 2.10). The modifications in the elastic modulus with aging were high enough to promote cracking at the surface for exposure times of 400 h and above, and were attributed to a continuous variation of the modulus with depth.

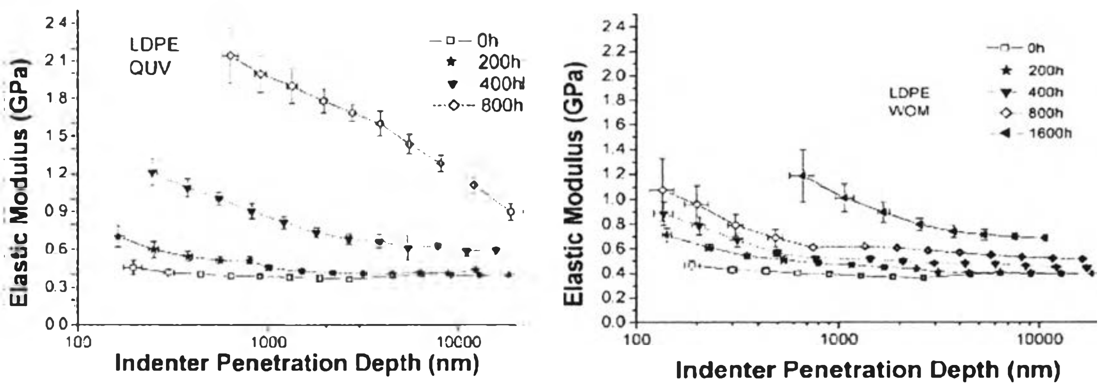


Figure 2.10 Variation of elastic modulus of QUV chamber (left) and variation of elasticmodulus of the WOM chamber (right).

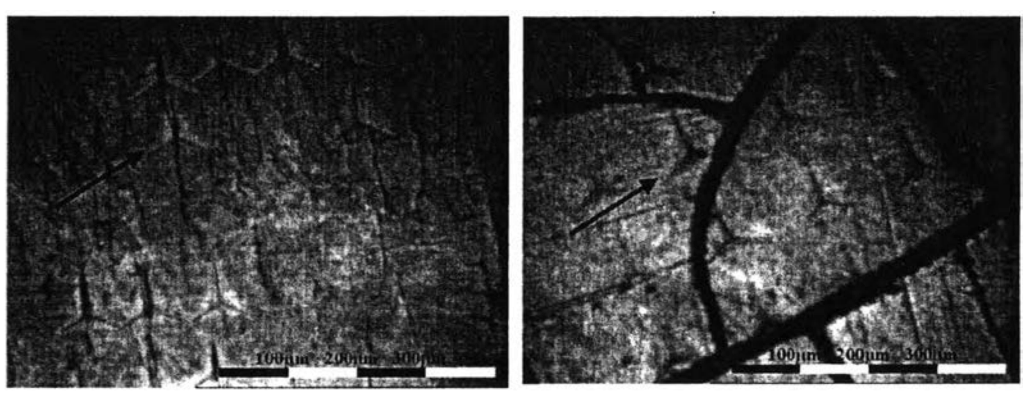


Figure 2.11 The cracked surface of LDPE aged during 1600 h in the WOM chamber (A) and 800 h in the QUV chamber (B).

The QUV aged samples did not present visible cracks for aging times lower than 400 h. In these samples some cracks with shallow depths were visible. The cracks are related to fracture induced in the surface by the aging process associated with thermal cycling. Figure 2.11 A and B The observed effects indicate that a higher degree of crosslinking must have been achieved in the QUV chamber, giving raise to higher stresses resulting in severe cracking in all directions

J. Attwood *et al.* (2006) studied the effects of ageing by ultraviolet degradation of recycled polyolefin blends. Samples were analyzed for changes in mechanical and optical properties. Data obtained in this study such as tensile, impact, gloss and color analyses showed that the effect of UV exposure. For color and gloss change, a stepwise increase on initial UV exposure was observed, followed by a sharp increase after 750 h of exposure. In case of tensile and impact were slight decrease at 100 h of exposure, the first point of testing, there had already been a decrease of about 30%. By 1000 h of exposure, the drop was about 50% after which the value remained constant. The apparent increase in tensile strength and decrease in impact strength suggested that a reduction in crystal size had occurred.

At 2007, Mikiya Ito *et al.* studied the comparison between a plasticized poly(vinyl chloride) in the weathering test (WEL-SUN-DC) and plasticized poly(vinyl chloride) in thermal aging (OVEN DN600) . The PVC surface was shown by SEM. According to the results of the observation of surface and section, different appearances between weathering and thermal aging were indicated. Figure 2.12 shown shows SEM image of the surface after the thermal aging test. A few small voids are also visible. However, the size and the number of voids were not changed. Case of weathering test shows a few voids is visible. With an increase of the weathering time, the size and the number of voids also increased (Fig 2.13).

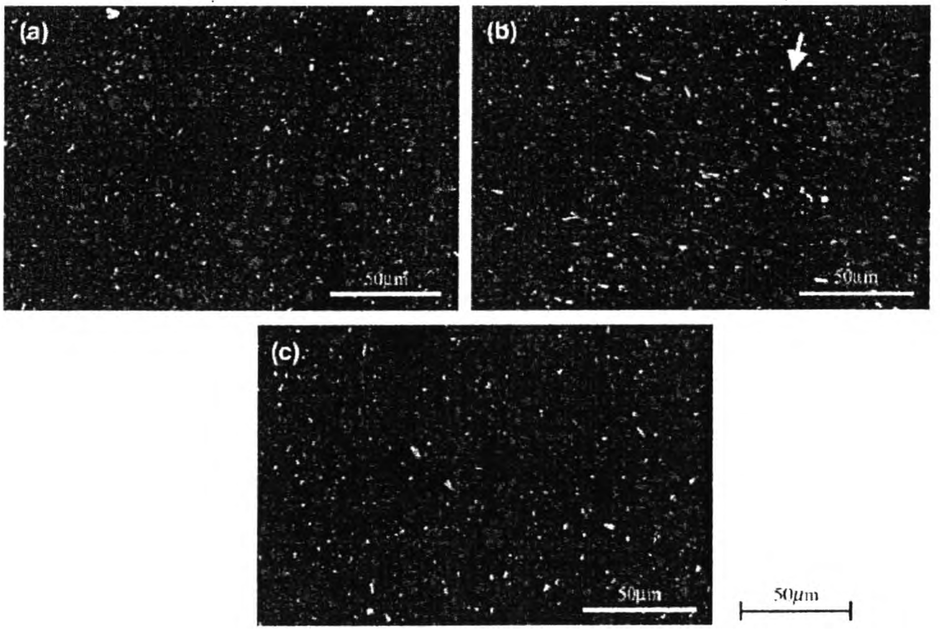


Figure 2.12 SEM images of the surface after the thermal aging test: (a) 0 h, (b) 100 h (the obvious void is pointed by arrow), and (c) 240 h.

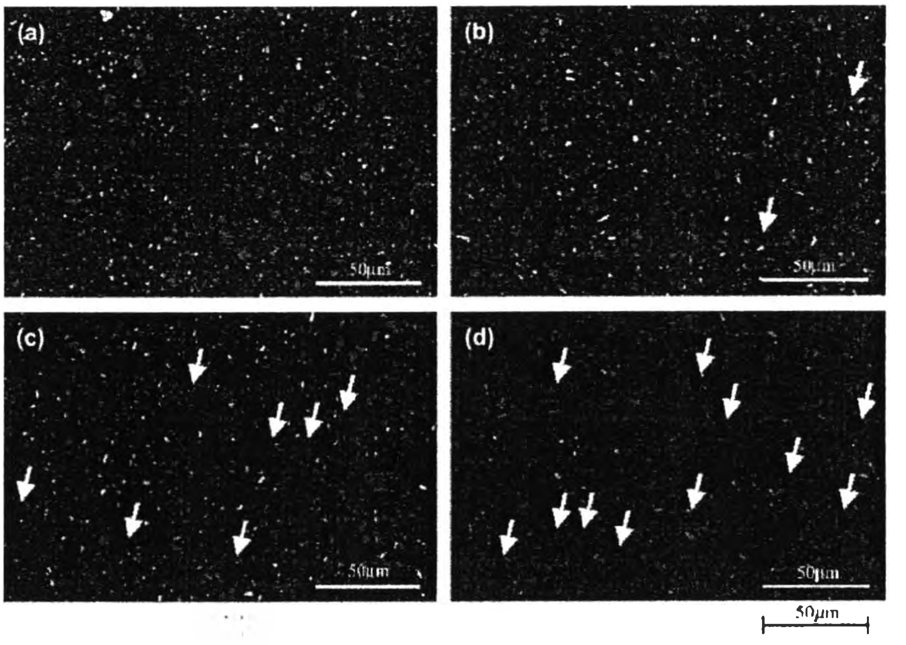


Figure 2.13 SEM images of the irradiated side of the surface after the weathering test: (a) 0 h, (b) 200 h, (c) 1000 h, and (d) 3000 h. The obvious voids are pointed by arrows.