JIS of ACM (Atmospheric Corrosion Monitor) type corrosion monitoring sensor (ACM sensor)

Tadashi Shinohara [1*] and Hideki Katayama [1]
[1] Corrosion Properties Group, Research Center for Structural Materials
National Institute for Materials Science (NIMS)

The ACM sensor is made by printing Ag paste (cathode) on carbon steel (Fe) or galvanized steel sheet (Zn) as the anode through an insulating layer, and measuring the short-circuit current flowing through galvanic couples. Information on environmental corrosivity can be measured in real time. It is marketed as a certified version by the Corrosion Center, Japan Society of Corrosion Engineering, and is widely used for environmental corrosivity evaluation from mild environments such as indoors to severe environments such as marine areas. There was an increasing voice that the sensor should be JIS-compliant in consideration of the supply and reliability of the sensor. Therefore, the Japan Society of Corrosion Engineering established a JIS drafting committee, and as a result of the examination, it was established in September 2019 as JIS Z 2384:2019 “Atmospheric Corrosion Monitoring Sensor”.

1. Introduction

The ACM sensor is made by printing Ag paste (cathode) on carbon steel (Fe) or galvanized steel sheet (Zn) as the anode through an insulating layer. By measuring the short-circuit current flowing through galvanic couples, information on environmental corrosivity can be measured in real time.

This sensor is sold as a certified version by the Corrosion Center, Japan Society of Corrosion Engineering, and is widely used for corrosion evaluation in various atmospheric environments. Considering the future supply of sensors and ensuring reliability, there is a growing voice that ACM sensors are JIS compliant, so we decided to establish a JIS drafting committee at the Japan Society of Corrosion Engineering and established JIS.

2. ACM sensor [1) 2)]

2.1 ACM sensor configuration

The configuration of the ACM sensor is shown in Fig. 1[1)2)]. An insulating layer and an Ag paste (cathode) were printed on the anode carbon steel (Fe) or galvanized steel sheet (Zn) by a precision screen printing technique. As a result, a sensor with excellent mass productivity and reproducibility can be manufactured, and even if the sensor has a life of several months, it is possible to collect long-term corrosion information by updating it.

2.2 Application of ACM sensor to atmospheric corrosion research

2.2.1 Monitoring of environmental factors

Detection of wet and dry

Since the magnitude and time variation of the ACM sensor output depending on whether it is rain or dew, it is possible to detect the dew, dry, and rain periods and obtain the respective durations (Fig. 2).

Sea salt deposition

The amount of deposited sea salt can be measured in real time from the ACM sensor output, I, and the relative humidity (RH) in dew period by referencing to the empirical I-RH calibrating curve [1) 2)]. Table 1 summarizes the results of determining the steady-state value (Ws) of deposited sea salt in each exposed site.

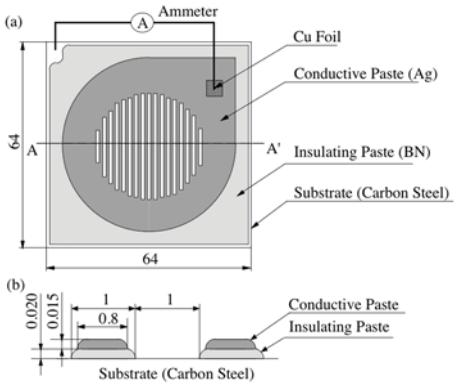


Fig. 1 Configuration of ACM sensor[1)2)].

*E-mail: SHINOHARA.Tadashi@nims.go.jp

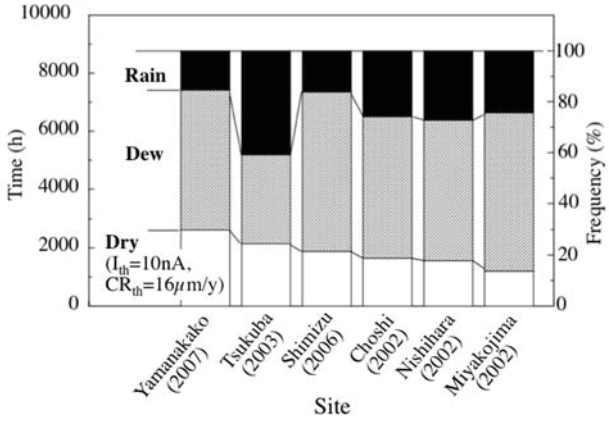


Fig. 2 Ratios of duration of rain, dew and dry periods (T_{rain}, T_{dew} and T_{dry}).

2.3 Corrosion behavior in an environment protected from direct rain

Carbon steel coupons and QCM were exposed with ACM sensors in various environments protected from direct rain, and corrosion rates, CR, of carbon steel and Fe electrode on QCM were measured. It was confirmed that the corrosion rate, CR, and the daily average electricity, Q, was found to reside on a fairly straight line as shown in Fig. 3 expressed as:

$$\text{Log CR [mm / y]} = 0.378 \text{ Log Q [C / day]} - 0.636 \quad (1)$$

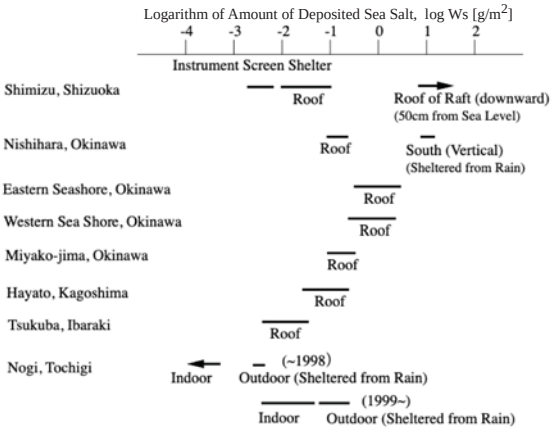
This indicates that the corrosion rate of carbon steel can be estimated from Q regardless of environmental conditions such as sea salt deposition and humidity conditions.

3. JIS standardization of ACM sensor

As mentioned in 2., the ACM sensor can be used to evaluate the corrosivity of the atmospheric environment and to estimate the corrosion rate in environments protected from direct rain. For this reason, ACM sensors have become widely used for corrosivity evaluation of environments from mild environments such as indoors to severe environments such as marine areas. In recent years, demand has been increasing in the Asian region as well, and from the perspective of future sensor supply and reliability assurance, there is a growing demand for ACM sensors to comply with JIS. Therefore, the Japan Society of Corrosion Engineering has established a JIS Drafting Committee and established JIS through the Japanese Standards Association.

The JIS drafting committee and subcommittee were formally established in January 2018, and after extensive discussions, the JIS draft was put together in October 2018 and submitted to the Japanese Standards Association. After that, the contents were reviewed between the Japanese Standards Association and the Japan Society of Corrosion Engineering. Following the deliberation by the JISC (Japanese Industrial Standards Committee) Technical Committee on Metals and Inorganic Materials in June 2019, it was designated as JIS Z 2384:2019 “Atmospheric Corrosion Monitoring Sensor” in September 2019“.

Table 1 Amount of deposited sea salt, Ws, under various environments.



4. Summary

ACM sensors have excellent mass productivity and reproducibility, and are widely used for environmental corrosivity evaluation from mild environments such as indoors to severe environments such as marine areas. In recent years, demand is increasing in the Asian region as well, and in consideration of future supply and reliability of the sensor, we have made the ACM sensor JIS, and established it in September 2019 as JIS Z 2384:2019 “Atmospheric Corrosion Monitoring Sensor".

References

1) Motoda Shin-ichi, Suzuki Yonosuke, Shinohara Tadashi, Kojima Yoichi, Tsujikawa Shigeo, Oshikawa Wataru, Itomura Shosuke, Fukushima Toshiro, Izumo Shigeto: Zairyo-to-Kankyo, 43, 550-556 (1994). (in Japanese)

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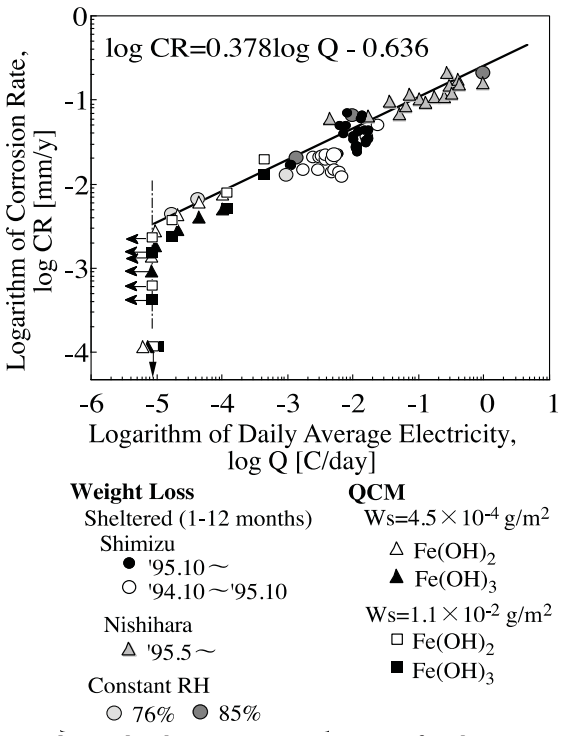

Fig. 3 Relationship between corrosion rate of carbon steel, CR, and daily average electricity, Q.