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Outgassing Measurements

on

Cable NASDA-QTS-1064

(Hitachi N1064/201-22-2SJ)

Prepared for:

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ASTM E 1559
Outgassing/Deposition Kinetics Test

Test Method

The material sample is placed in a temperature-controlled effusion cell in a vacuum chamber. Outgassing flux leaving the effusion cell orifice impinges on four QCMs which are controlled at selected temperatures. One of the QCMs is at 80 K to collect essentially all the impinging species. The total mass loss (TML) and outgassing rate from the sample are determined as functions of time from the mass deposited on this QCM and the sample-to-QCM view factor. The percent of outgassing species which are condensable on higher temperature surfaces is referred to as Volatile Condensable Material (VCM) and is measured as a function of time from the mass collected on the warmer QCMs, which are temperature-controlled appropriately. The QCMs and effusion cell are surrounded by liquid nitrogen shrouds to ensure that the molecular flux impinging on the QCMs is due only to the sample in the effusion cell.

After the isothermal outgassing test, a QCM thermogravimetric analysis (QTGA) is performed on the collected outgassed species. The QCMs are heated at a controlled rate from their base temperatures to 398 K in order to volatilize the collected species. During this QCM heat-up the mass remaining on the QCMs is measured as a function of time and temperature.

In general, the species condensed on the QCMs have different evaporation characteristics (volatilities) and hence will leave a QCM surface at different temperatures during QTGA. Therefore, QTGA data are characterized by temperature regimes in which the deposit mass remaining on the QCM decreases due to evaporation of a particular species, separated by temperature regimes in which no species evaporate. The number of temperature regimes in which species are evaporating from the QCM indicates the number of major groups of species that were present in the outgassing flux. The relative amount of a given species in the outgassing flux can be estimated from the ratio of the mass loss associated with the evaporation of that species to the total deposit mass on the QCM. QTGA also provides an effective means for cleaning the QCM surfaces before subsequent outgassing tests.

The species outgassed from the sample during the isothermal test, and evaporating from the QCM during the QTGA also are monitored using a mass spectrometer. While the QCMs provide quantitative outgassing and deposition data, the mass spectrometer records the intensities of mass peaks which aid in the identification of the outgassed species.

Test Parameters

Outgassing testing was performed using the following chamber and test parameters.

- Chamber pressures were 10^{-10} to 10^{-8} torr
- View factor from a QCM to the sample was 415.02 cm^2
- Sensitivity of each of the four QCMs was 4.43 x 10^{-9} $g/cm^2/Hz$

References

° ASTM E 1559, "Standard Test Method for Contamination Outgassing Characteristics of Spacecraft Materials."

° J.W. Garrett, A.P.M. Glassford, and J. M. Steakley, "ASTM E1559 Method for Measuring Material

° A.P.M.Glassford and J.W.Garrett, "Characterization of Contamination Generation Characteristics of Satellite Materials", Final Report WRDC-TR-89-4114, Jun 82 - Aug 89

ASTM E 1559
Outgassing/Deposition Kinetics Test

Test Sample:
Cable NASDA-QTS-1064

Material Description:

The material consisted of a 2-conductor shielded cable with grey-white insulation. The cable had been manufacturered by Hitachi and had a part number of N1064/201-22-2SJ.

Material Packaging:
The cable was wrapped in foil then single-bagged in a clear plastic zip-lock bag. This was then packaged in another zip-lock bag that also contained a note having the sample name, manufacturers identification number, and weight/dimension information.

Sample Description:
The cable was 100.0 cm long and had a nominal diameter of 0.130 inches. The cable was placed in the effusion cell and tested without any preconditioning.

Material Supplier:

The sample was supplied by Takeshi Nagano in the Utilization & Engineering Department of JAMSS in Japan.

Sample Preconditioning:

The sample was tested with no additional preconditioning.

Sample Length: 100.0 cm
Mass of Sample: 24.72270 grams

Sample Temperature: 54.0 °C

Test Duration: 144 hr
QCM Temperatures: 80 K 233 K 263 K 298 K

Isothermal Data File: JAN1403G

QTGA Data File: JAN2003R

Isothermal Test - QCM Data:
QCM data from the end of the outgassing test are summarized in Table 1.

Table 1

	(μg/cm)		(%)		(% of TML)
80 K TML =	55.45	=	0.02243	=	100.0
233 K VCM =	0.92	=	0.00037	=	1.7
263 K VCM =	0.36	=	0.00015	=	0.6
298 K VCM =	0.08	=	0.00003	=	0.1

Total outgassing rate data for the sample were calculated by differentiating the data obtained from the 80 K QCM. Figures showing these total outgassing rate data as a function of test time are attached. These

QCM Thermogravitmetric Analysis - QCM Data:

The QTGA test data can be used to determine the relative amounts of the species outgassed. As the temperature of the 80 K QCM is increased during QTGA, the collected species will evaporate from the

Mass Spectrometer Data:
Data from the in situ mass spectrometer are sometimes used to help identify the outgassed species. Identification of outgassed species is not within the normal scope of work for this testing and is not ordinarily pursued because of the analysis time required. However, observations on some of the species that are contributing to the outgassing flux from the sample have been noted below. Species identifications are based on engineering and chemistry experience and have not been confirmed by comparison with standards.

Species	Relative Abundance	Characteristic Ions (m/z)
water	major	18
hydrocarbons	minor	55, 57, 69, 71, 81, 83, 95, 97, 109, 111
possible fluorocarbons	minor	19
antistatic agent	trace	59, 72

Water, hydrocarbons, and the possible fluorocarbons were still present in the outgassing flux at the end of the 144-hour test.

Attachments:

Figs. 1(a-b). Total Mass Loss from the Sample as a Function of Test Time.
(Species Condensable on the 80 K QCM)

Figs. 2(a-b). Volatile Condensable Material from the Sample on the Warmer QCMs as a Function of Test Time.

Figs. 3(a-b). Total Outgassing Rate for the Sample as a Function of Test Time.
(Species Condensable on the 80 K QCM)

Figs. 4(a-b). QTGA Data: Evaporation Rate from the 80 K QCM of the Collected Outgassed Material as a Function of QCM Temperature.

Cable NASDA-QTS-1064 at 54°C.

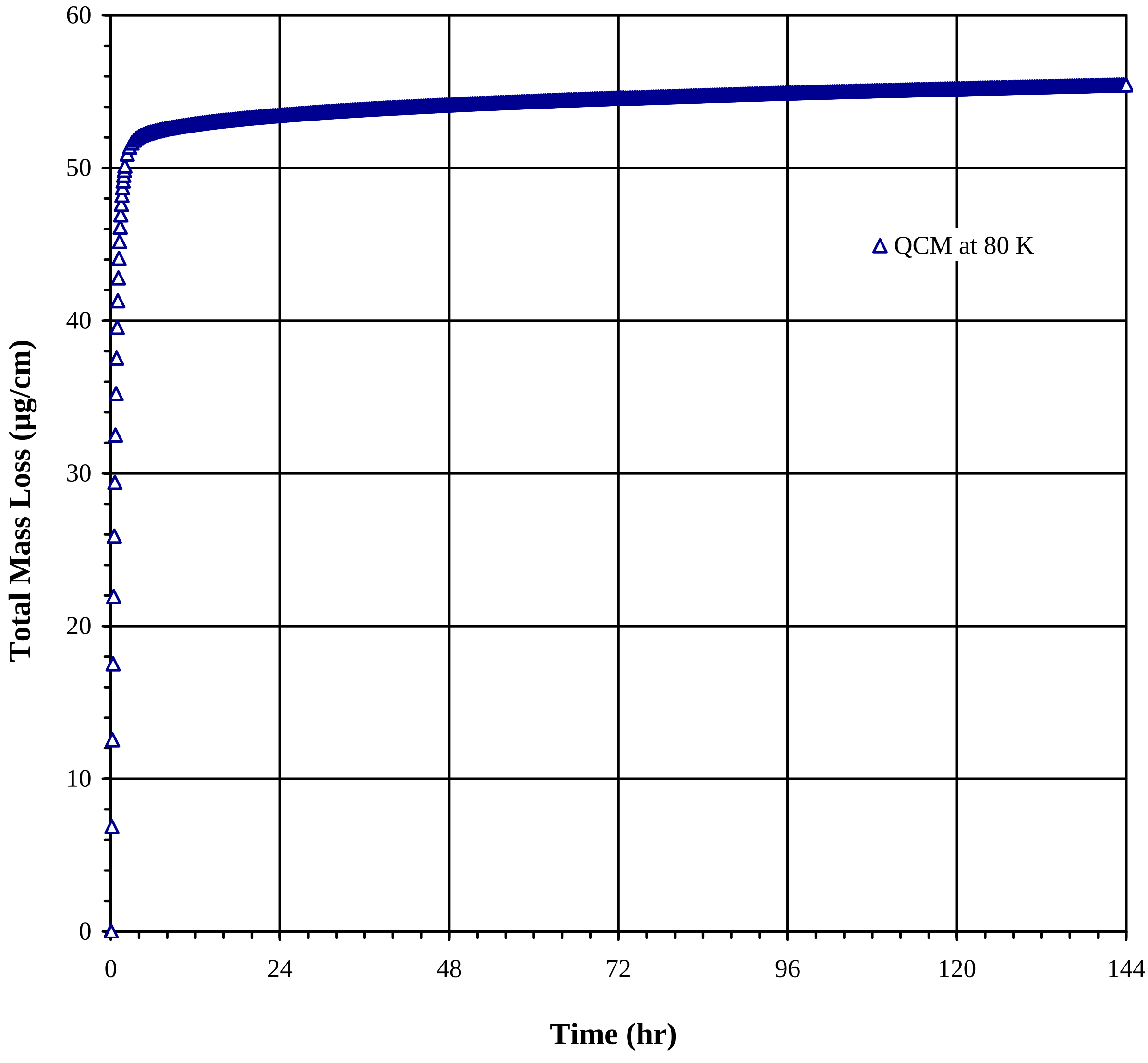

Fig. 1(a)

Cable NASDA-QTS-1064 at 54°C.

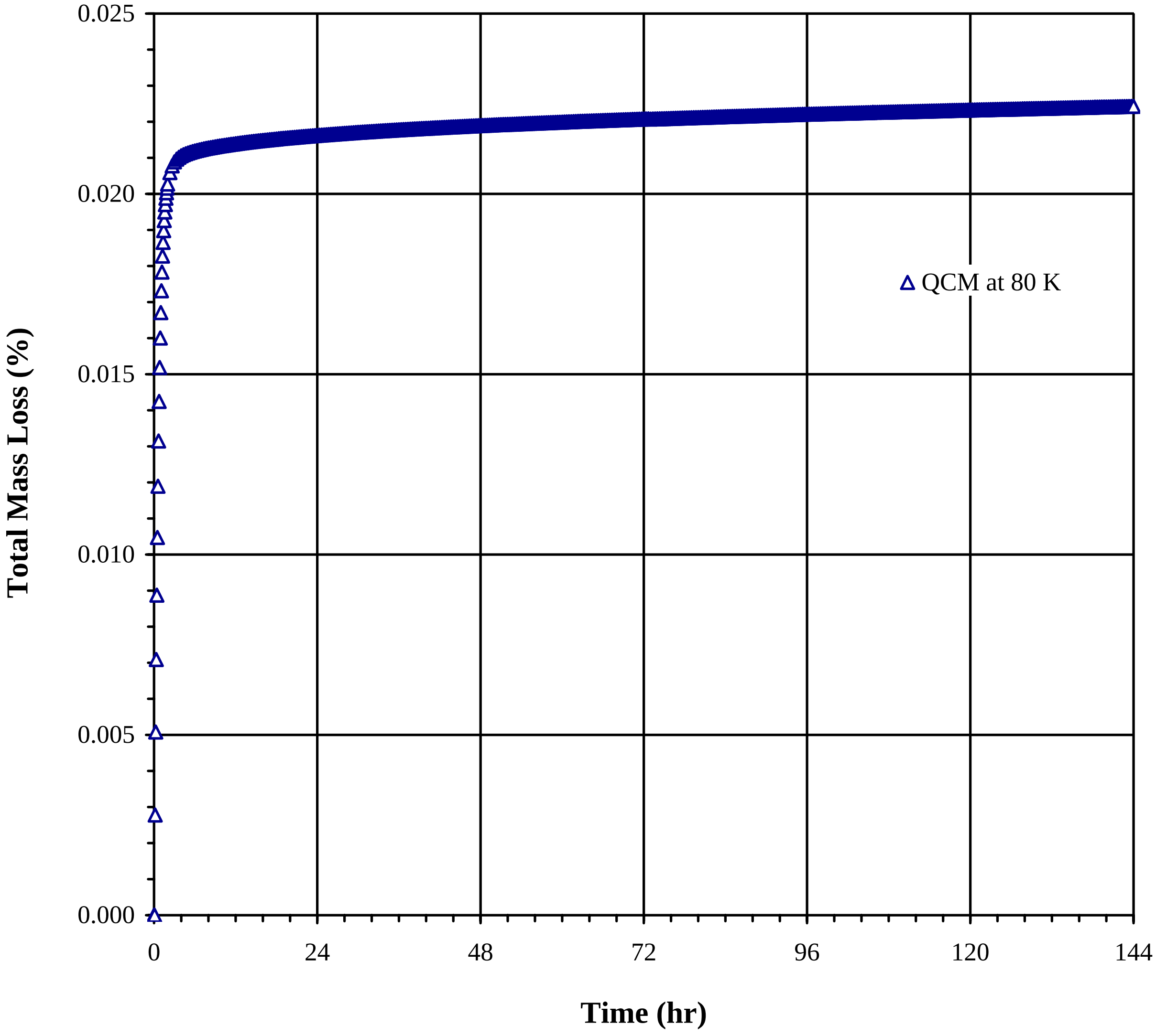

Fig. 1(b)

Cable NASDA-QTS-1064 at 54°C.

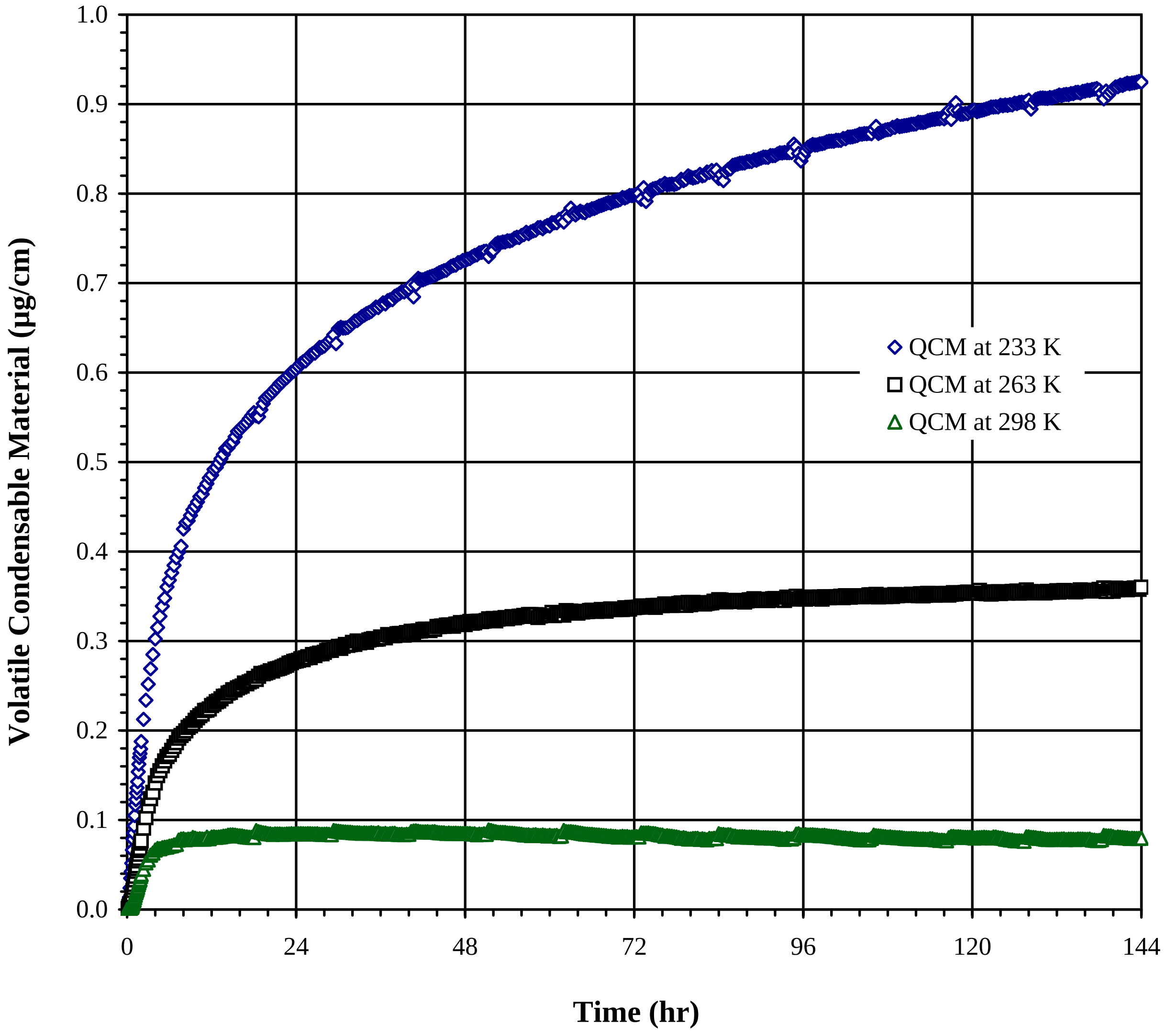

Fig. 2(a)

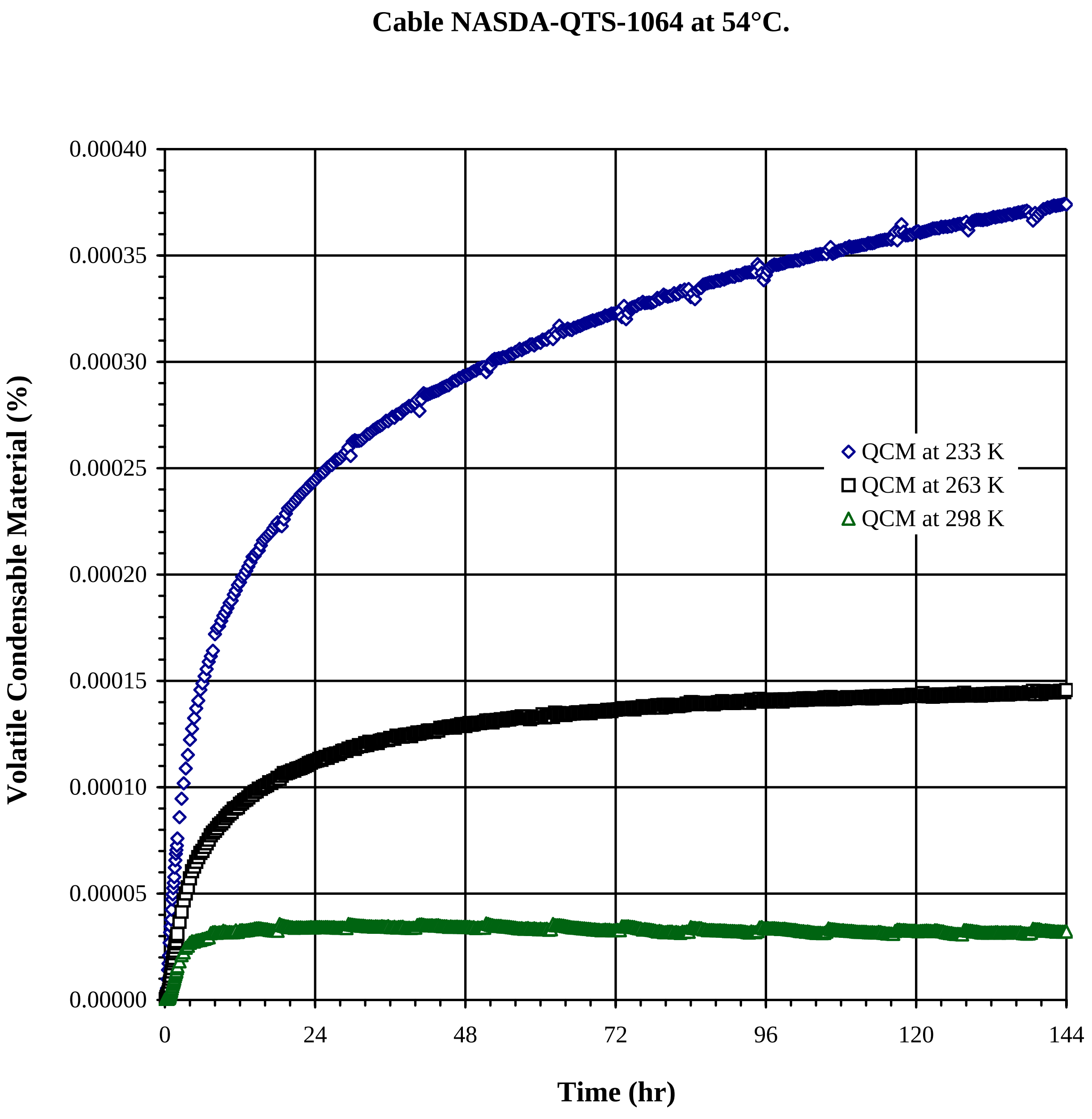
Cable NASDA-QTS-1064 at 54°C.
Volatile Condensable Material (%)
0.00040
0.00035
0.00030
0.00025
0.00020
0.00015
0.00010
0.00005
0.00000
0
24
48
72
96
120
144
Time (hr)
QCM at 233 K
QCM at 263 K
QCM at 298 K

Fig. 2(b)

Cable NASDA-QTS-1064 at 54°C.

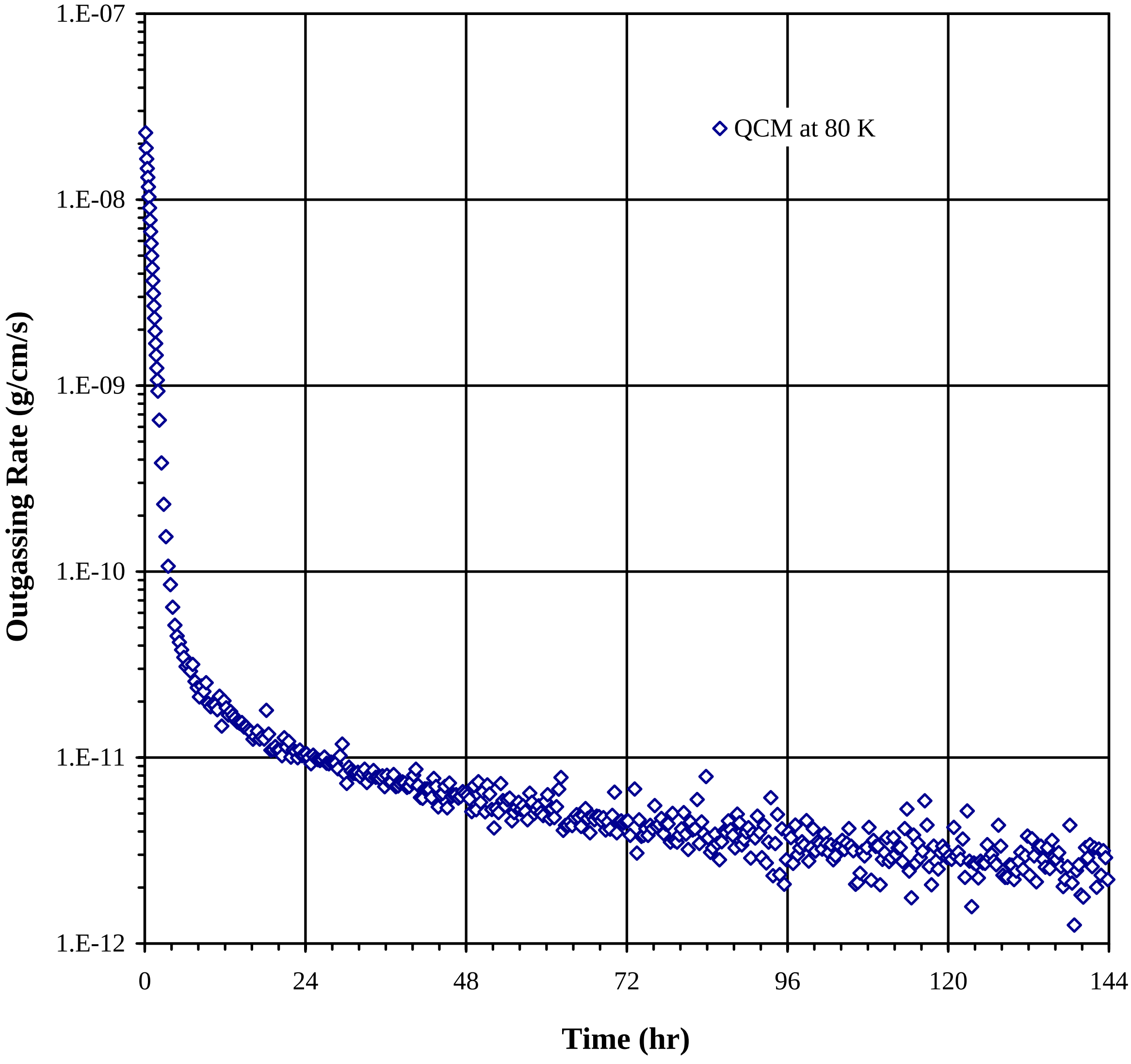

Fig. 3(a)

Cable NASDA-QTS-1064 at 54°C.

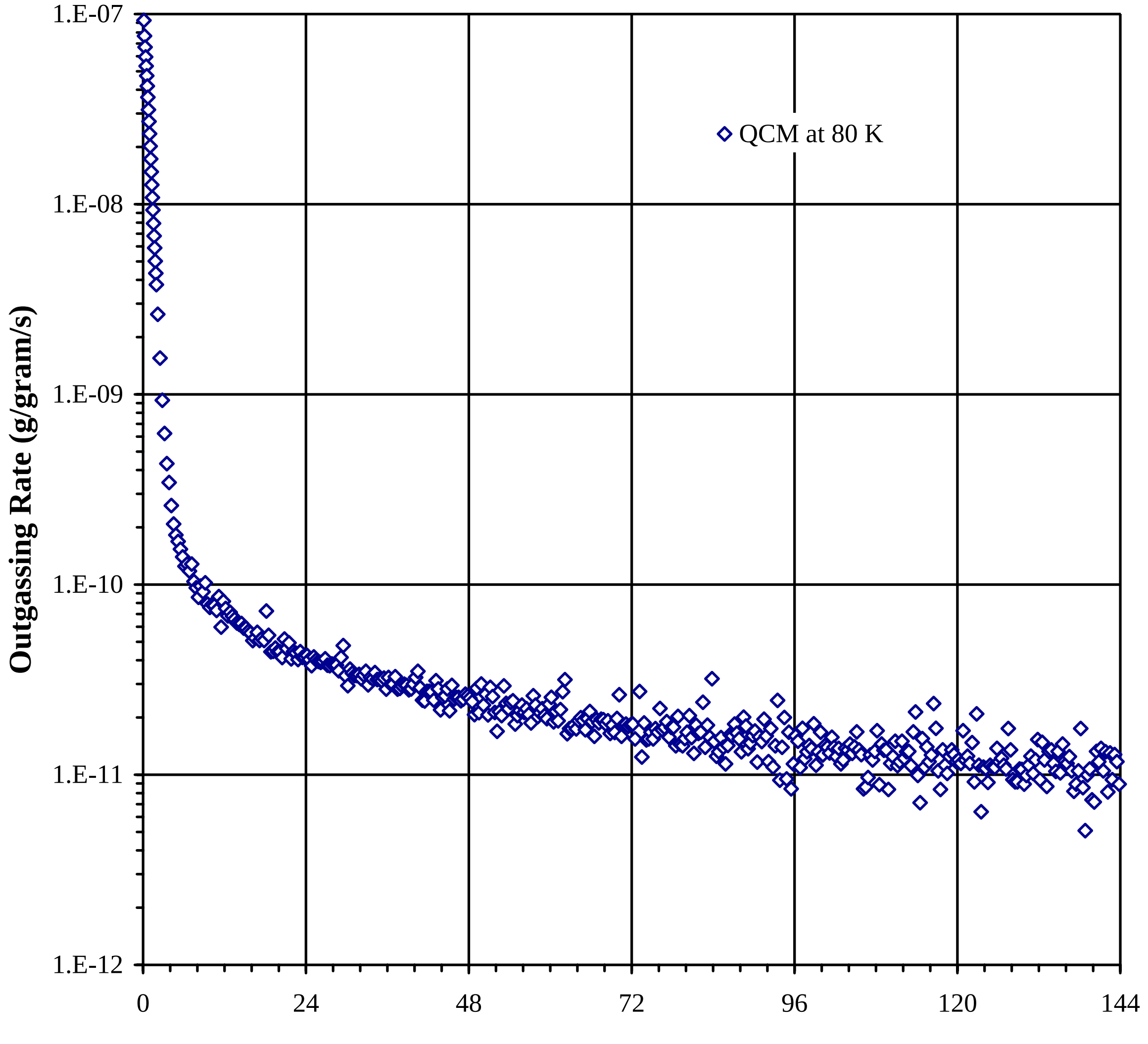

Fig. 3(b)

QTGA after Cable NASDA-QTS-1064 at 54°C.

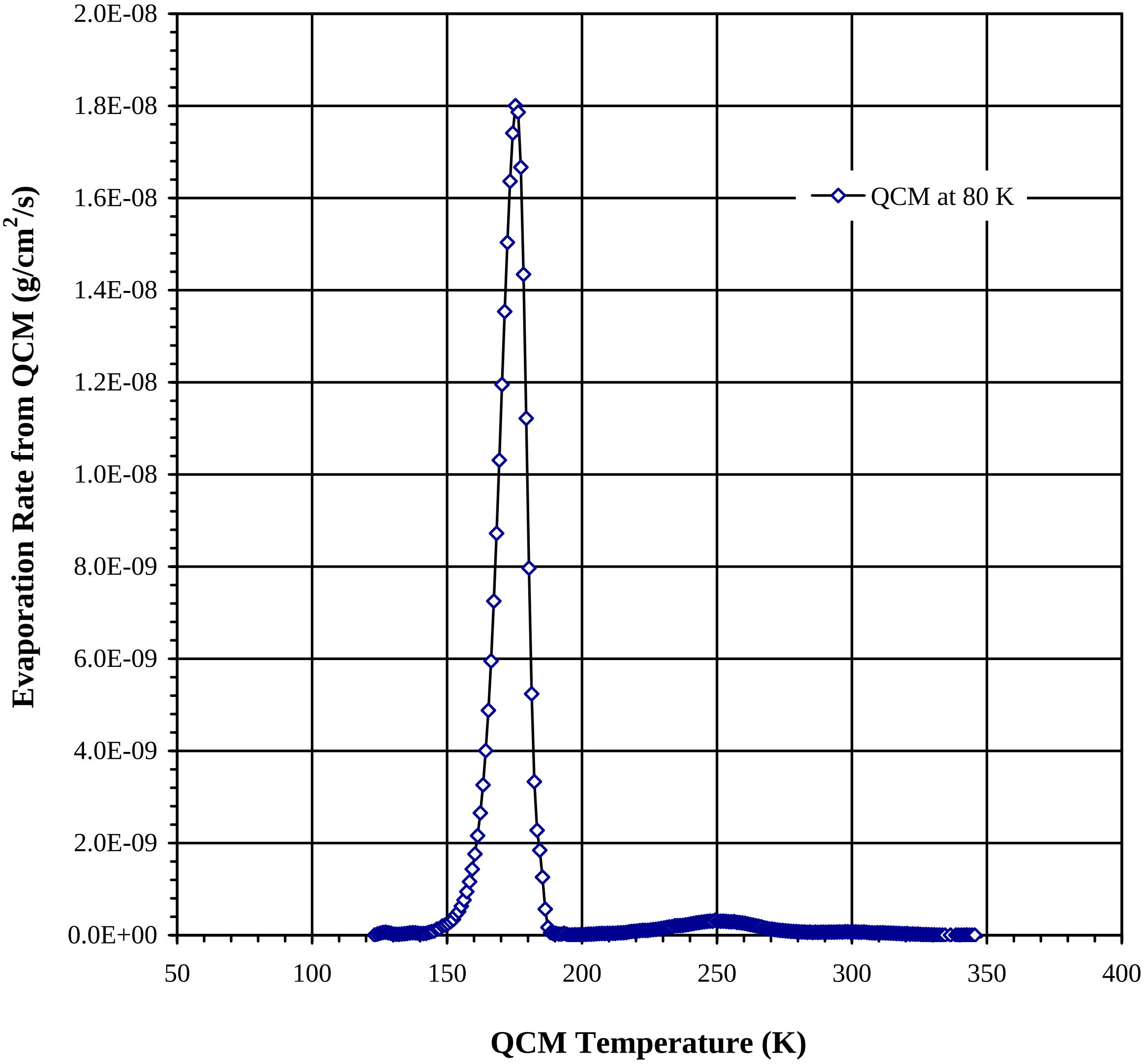

Fig. 4(a)

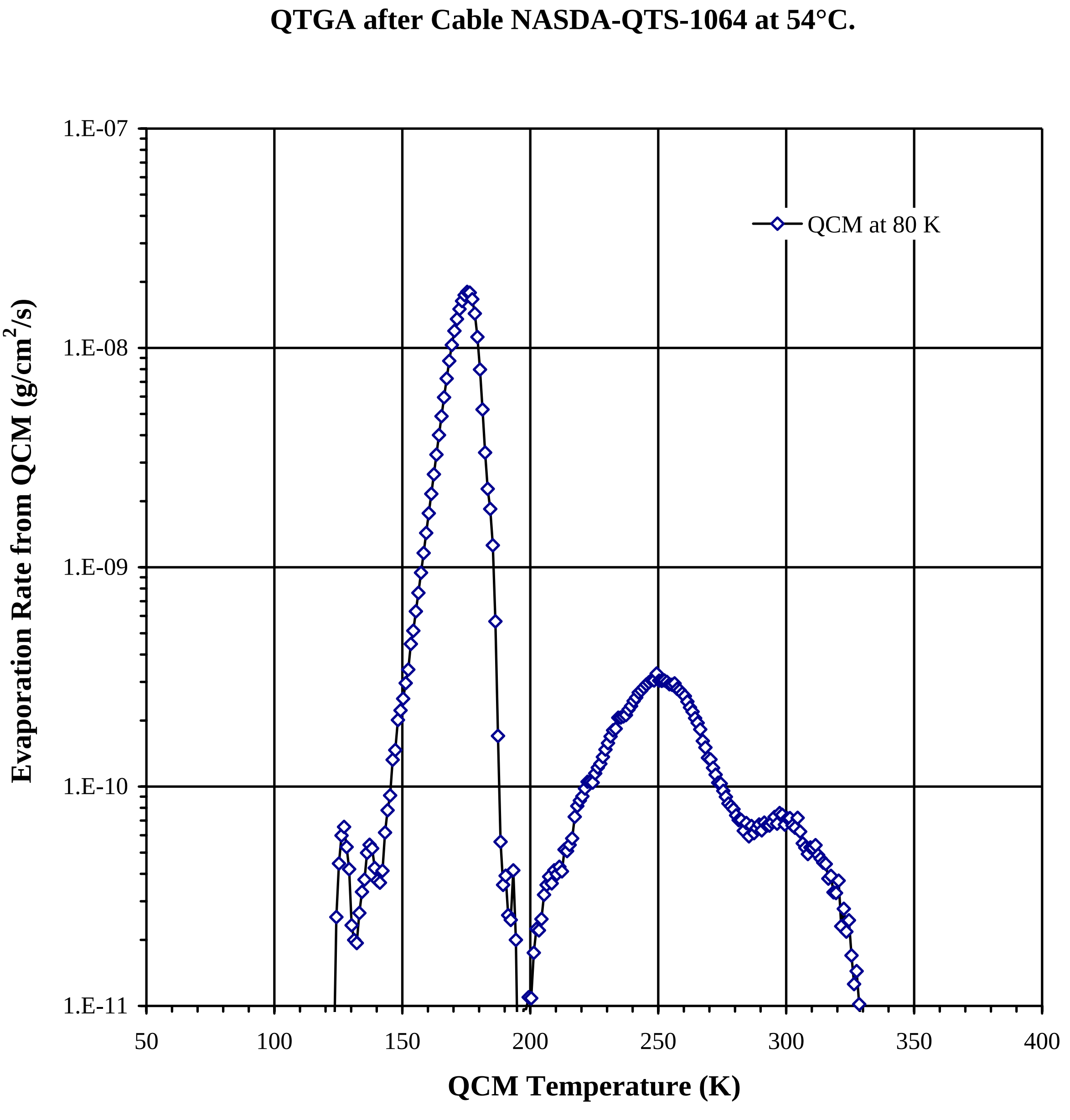
QTGA after Cable NASDA-QTS-1064 at 54°C.
1.E-07
1.E-08
1.E-09
1.E-10
1.E-11
Evaporation Rate from QCM (g/cm2/s)
QCM at 80 K
50
100
150
200
250
300
350
400
QCM Temperature (K)

Fig. 4(b)