A Study of Long-term Sensitivity Changes in the Backplate of Electret Type Condenser Microphones

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Abstract: An estimate of the surface charge decay and the lifetime due to the decreasing sensitivity of a usual electret condenser microphone (ECM) using a membrane electret as a diaphragm has already been reported upon by the authors. (1) A backplate electret type condenser microphone (BECM) is constructed with a backplate that has an electret material adhered to it. A BECM can be made with rather high sensitivity even in a small size by using a thin membrane as a diaphragm. The long-term sensitivity changes of such BECMs have not been made clear. We have, accordingly, studied the estimation of long-term surface charge decay of a backplate electret and sensitivity changes of BECMs. As a result, it was found that the surface charge decay of BECMs are less than those of a membrane electret type. On the other hand, sensitivity changes due to the loosening of membrane tension of the backplate type are greater than those of the membrane electret type.

INTRODUCTION

As factors concerning sensitivity changes in a BECM, the following are considered: (1) the surface charge decay of electret material, (2) the loosening tension of the diaphragm over a period of time, (3) the modification in BECM housing construction. In this paper, however, we have studied about factors (1) and (2) for simplification. We also have conducted a heat acceleration test for the electret surface charge, on the backplate and from the results of charge decay characteristics, we have estimated the surface charge decay over a period of time. As the thickness of the diaphragm of a BECM is thinner than that of a membrane electret type, it has been estimated that sensitivity increases by the loosening of membrane tension. Therefore, we have conducted another heat acceleration test for membranes, and have used the results for the estimation of total sensitivity changes of a BECM.

CONSTRUCTION OF BECM

A schematic cross-section of a BECM is shown in Fig. 1. Electret material that is made from Fluoroethylene-propylene (FEP) is adhered to the backplate. Therefore, electret charges are kept on the top surface of the backplate. The membrane as a diaphragm is made from a thin plastic foil (4 μm) that is metal plated on one side. The sensitivity of a BECM is proportional to surface charge volume C and inversely proportional to membrane tension T. (1) Accordingly, we assumed that the factors of sensitivity changes over a period of time are mainly due to surface charge decay and loosening tension of the membrane.

FIGURE 1. A schematic cross-section of a BECM.
THE CHARGE DECAY OF BACKPLATE ELECTRET

The surface charge decay on the backplate can be estimated from decay characteristics shown by heat acceleration tests. The surface charge decay curves illustrated by heat acceleration test are shown in Fig. 2. The temperatures for circumstances of the test are 85°C, 105°C, 120°C, and 150°C, respectively. Changes of surface charge potential from their initial values were shown with dB levels the same as the decay in microphone sensitivity. In Fig. 2, the curves of 60°C, 40°C, and 20°C are drawn by estimation from the resulting curves of the heat acceleration test from 150°C to 85°C. From the results of the heat acceleration test, the surface charge decay characteristics from using an empirical formula by Arrhenius, are shown as Fig. 3. In this figure, the parallel lines are drawn along the equi-charge values, and the surface charge decay that stored for about 10 years at room temperature is estimated to be about –0.1 dB referred to as microphone sensitivity.

In the case of a membrane electret type, the surface charge decay over the same span of time, and at room temperature was about –1.0 dB. Therefore, it was clear that the surface charge decay of a backplate electret is less than that of a membrane type. On the other hand, the sensitivity changes of BECMs kept 9 years in a laboratory at room temperature showed 1.0 dB. Since it is hardly considered that surface charges on electret material increase in total volume over passing time, therefore, the reason of the increasing sensitivity of a BECM may be considered to be due to the loosening of membrane as a diaphragm.

Accordingly, the increasing sensitivity of the BECM due to the loosening membrane may be presumed to be about 1.1 dB from the estimation line of Fig. 3. These values show that the surface charge of a BECM is longer than that of the membrane electret type. The increasing sensitivity due to loosening the membrane of a BECM is larger than in the case of a membrane electret type.

CONCLUSIONS

In order to estimate the long-term sensitivity changes of a BECM, we have conducted a heat acceleration test for a backplate electret. The results showed that the surface charge decay of a backplate electret is less than that of membrane electret type over the same time span. The looseness of the thin membrane of a BECM, however, is larger than that of the usual membrane electret type. Therefore, the total sensitivity of a BECM over a long span, have the tendency to go up by loosening the membrane. From the above, it can be said that if we use a stable material for the membrane as a diaphragm, the total sensitivity change of a BECM will be rather small.

REFERENCES