

The relationship between structure of polyurethane foam sandwich panels and the frequency response

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ABSTRACT A series of classical sandwich composite panels composed of polyurethane (PU) foam core and epoxy laminate or paper panel skin were prepared. The relationships between the compositions or structures of polyurethane (PU) foam and frequency response of distributed mode loudspeaker tested by the conventional methods were studied. The experimental results show that the sensitivity and frequency area of the sandwich panels are effected by the composition, cell size, cell ratio, cell open ratio and thickness. The damping of polymer and the air content in core, the frictional resistance and the reflection on interface acoustic wave transmitting in the sandwich panels are internal causation.

KEY WORDS organic polymer materials, polyurethane foam, sandwich panel, frequency response, loudspeaker

Table 1 The properties of PU foam sandwich panels (paper skin) with various compositions

| No. | Mass fraction of polyether polyol parts | Sensitivity /dB | Frequency area /Hz |
|------|--|--------------------|-----------------------|
| PU-8 | G303 80 PPG220 20 | 64.6 | 40~2100 |
| PU-1 | G303 100 | 73.1 | 50~3800 |
| PU-2 | 450M 100 | 78.6 | 45~7000 |

Note: Average function of polyether: 2 for PPG220, 3 for G303; Average molecular mass of polyether: 2000 for PPG220, 3000 for G303, 540 for 450M

Table 2 Properties of PU foam sandwich panels with various cell ratio

| No. | Cell ratio/% | Density/(g/cm ³) | Sensitivity/dB | Frequency area/Hz |
|------------|--------------|------------------------------|----------------|-------------------|
| PU-4-paper | 98.57 | 0.189 | 78.0 | 33~6500 |
| PU-3-paper | 98.19 | 0.228 | 78.1 | 40~6200 |
| PU-6-paper | 97.36 | 0.322 | 73.6 | 35~8000 |
| PU-4-ep | 98.57 | 0.325 | 83.5 | 60~6700 |
| PU-3-ep | 98.19 | 0.343 | 73.4 | 50~6000 |
| PU-6-ep | 97.36 | 0.388 | 73.9 | 90~8000 |

Table 3 Properties of PU foam sandwich panels (paper skin) with various cell size

| No. | Cell size/mm | Sensitivity/dB | Frequency area/Hz |
|-------|--------------|----------------|-------------------|
| PU-22 | 0.097 | 62.9 | 38~8000 |
| PU-21 | 0.110 | 65.5 | 42~7800 |
| PU-23 | 0.130 | 66.5 | 46~7500 |

Table 4 Properties of PU foam sandwich panels with various cell open ratio

| No. | Cell open ratio/% | Sensitivity/dB | Frequency area/Hz |
|-------------|-------------------|----------------|-------------------|
| PU-16-paper | 2.39 | 64.8 | 40~8000 |
| PU-11-paper | 2.55 | 67.3 | 30~3000 |
| PU-12-paper | 2.76 | 68.3 | 30~2400 |
| PU-14-paper | 4.53 | 69.9 | 45~1500 |
| PU-16-ep | 2.39 | 67.1 | 30~8000 |
| PU-12-ep | 2.76 | 70.0 | 20~8500 |
| PU-14-ep | 4.53 | 74.9 | 40~4000 |

Table 5 Properties of PU foam sandwich panels with various thickness

| No. | Thickness/mm | Sensitivity/dB | Frequency area/Hz |
|----------------|--------------|----------------|-------------------|
| PU-3 mm-paper | 3 | 73.1 | 50~2300 |
| PU-5 mm-paper | 5 | 71.9 | 50~2000 |
| PU-7 mm-paper | 7 | 67.7 | 100~2300 |
| PU-10 mm-paper | 10 | 67.4 | 90~2600 |
| PU-3 mm-ep | 3 | 66.4 | 30~8000 |
| PU-5 mm-ep | 5 | 64.2 | 80~9000 |
| PU-7 mm-ep | 7 | 60.8 | 90~7000 |
| PU-10 mm-ep | 10 | 60.4 | 110~10000 |