The Influence of Foam Materials on the Frequence Response Performance of Ear Cushion Experimental Testing and FEM Simulation

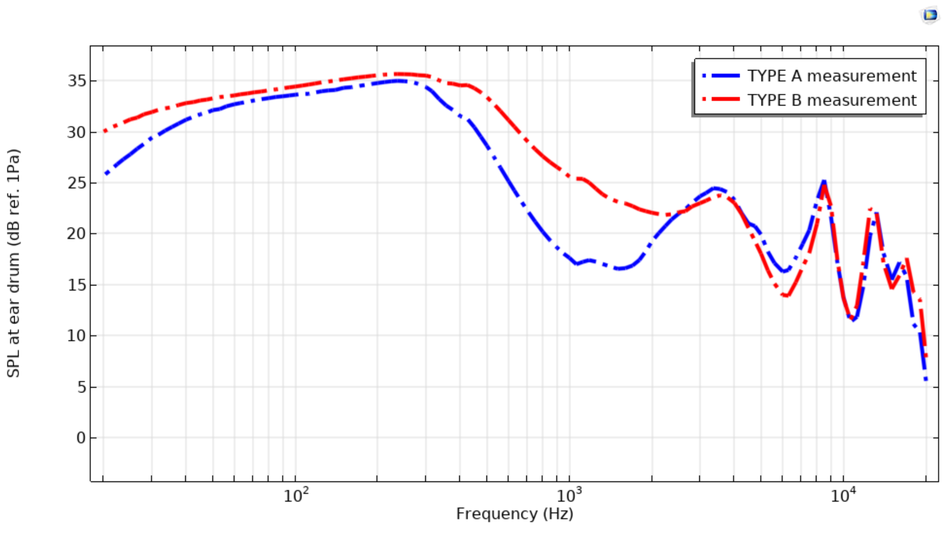
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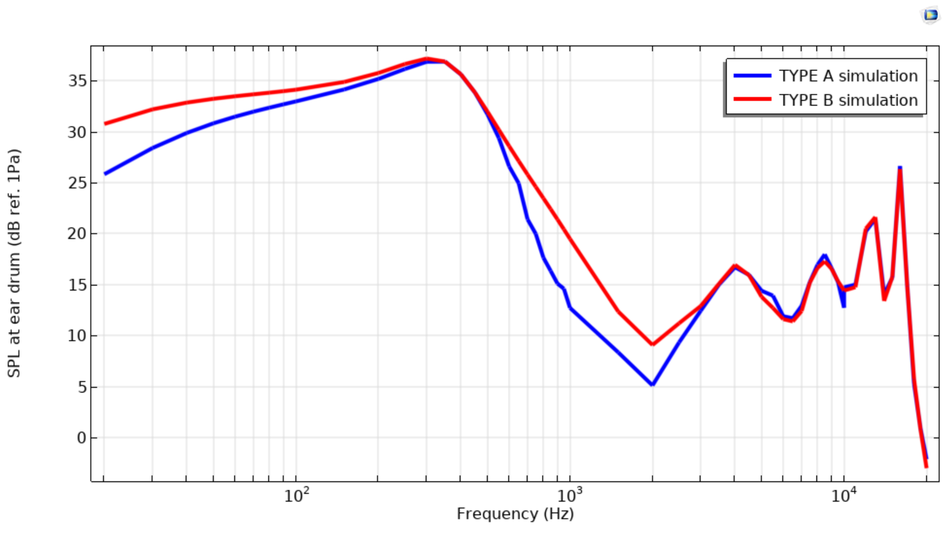
Introduction

Foam, as the internal filling material for headphone ear cushion, has a significant influence on user experience (UX) as well as the acoustic performance (PNC & FR) of headphones. Selecting the appropriate foam in practical product development is therefore critical, and a thorough understanding of foam materials is essential.

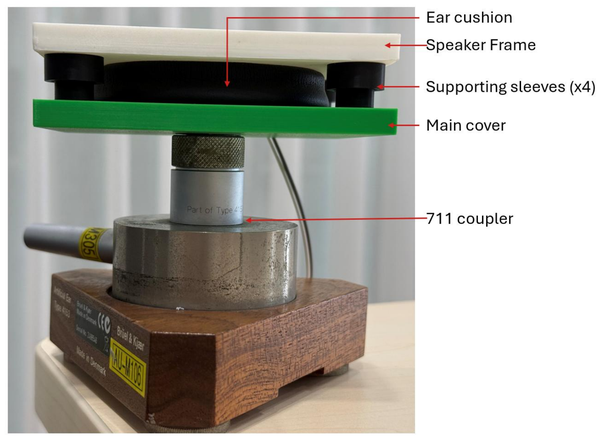
To investigate the acoustic properties of different foams and their effects on frequency response, we measured the Johnson-Champoux-Allard (JCA) parameters of two typical foam materials and validated them in COMSOL. Furthermore, we designed a test fixture to obtain assembled module for simplified frequency response analysis. By comparing measurements with simulation result, we show that the simulation can reproduce the differences in the frequency response of the assembled module caused by different foam materials. This simulation method could be applied in frequency response analysis of more complex headphone designs.



FR measurement result of two foams



FR simulation result of two foams



Conclusion

While further refinements are still needed, we believe the work shown in this poster provides valuable insights, including:

1) Provide an enhanced understanding of FR performance in ear cushions with foam material through systematic testing and simulation;
2) Propose an accurate approach to predict how various foam materials affect the frequency response of ear cushion and complete headphone;
3) Develop a simulation framework that enables more accurate FR prediction in early design phases, supporting data-driven optimization of both structural design and foam material selection.