ACOUSTICS2008/2172
Thin film thermo-viscous damping in miniature condenser microphones

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The thermo-viscous damping due to the thin fluid film between the membrane and the backing electrode strongly influences both the sensitivity of the condenser microphones in the lower frequency range and the upper limit of the frequency bandwidth. Nowadays, most of the MEMs microphones use a perforated backing electrode while some authors suggest that a continuously curved backing electrode could enhance their performances (among avantages in the design when etching). The present paper provides two kinds of modeling for such microphones with a tapered fluid film: the first one lies on Kirchhoff-network analysis (neglecting cross-coupling between elements) whereas the second one is based upon the direct resolution of the set of basic equations (including heat transfer phenomena). The results are presented and discussed for both models in the cases of flat, parabolic, and stepped shapes backing electrode. Finally, the pressure field in the fluid film, computed (for an axisymmetrical configuration) using the above-mentioned models, is compared to the one computed with a new FEM formulation taking into account both viscous and thermal phenomena in the boundary layers.