On the influence of the micro-geometry on sound propagation through periodic array of cylinders

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Sound propagation in rigid porous media has been widely studied by using semi-phenomenological models. These models make use of a set of averaged macroscopical parameters to represent the microscopic details of the porous media geometry and, in a certain way, their influence on the acoustical properties is not directly identified. In this paper, homogenization theory and finite element method are used for solving the full microscopic dynamic flow and heat transfer problems for a porous medium modelled as an idealized periodic array of cylinders. Different cross-section shapes of the cylinders (circular, ellipsoidal and square) and a wide range of porosity values are considered. The full simulations are compared with standard semi-phenomenological models of sound propagation in porous media. The influence of the micro-geometry on the acoustical quantities such as speed of sound, attenuation coefficient and absorption coefficient is analysed and proved to be significant especially at low porosities.

This document is the additional material of the paper:

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The reader is referred to the cited paper to understand the nomenclature and figures.

	k_0/l^2	k_0'/l^2	α_∞	Λ/l	Λ'/l	α_0	α_0'
PACC	0.0776	0.1633	1.2002	1.2081	2.0185	1.4673	1.1513
PASC0	0.0723	0.1460	1.2402	1.0640	1.7889	1.5493	1.1617
PASC15	0.0685	0.1471	1.2439	1.0488	1.7889	1.5526	1.1654
PASC30	0.0593	0.1496	1.2527	1.0074	1.7889	1.5599	1.1729
PASC45	0.0535	0.1511	1.2579	0.9804	1.7889	1.5608	1.1766
PAEC0	0.0256	0.1587	1.5356	0.7811	1.8513	1.9096	1.1839
PAEC15	0.0316	0.1552	1.4795	0.8436	1.8513	1.8406	1.1785
PAEC30	0.0477	0.1487	1.3618	0.9848	1.8513	1.6835	1.1641
PAEC45	0.0698	0.1458	1.2436	1.1453	1.8513	1.5200	1.1554
PAEC60	0.0942	0.1487	1.1514	1.2923	1.8513	1.3989	1.1641
PAEC75	0.1159	0.1552	1.0943	1.3976	1.8513	1.3284	1.1785
PAEC90	0.1253	0.1587	1.0751	1.4360	1.8513	1.3040	1.1839

Table A.1: Macroscopical Parameters used in JCAL and PJCAL, $\phi = 0.8$

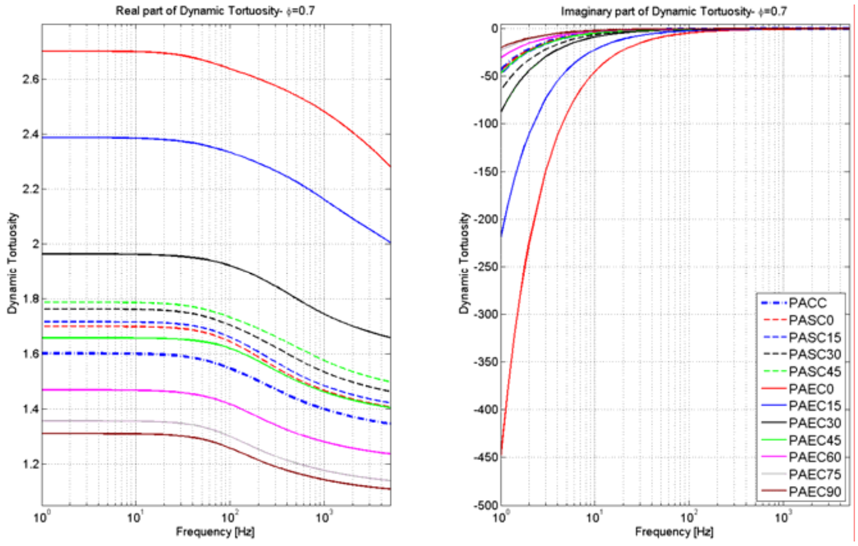

Fig A.1 Dynamic tortuosity ($\phi = 0.7$).

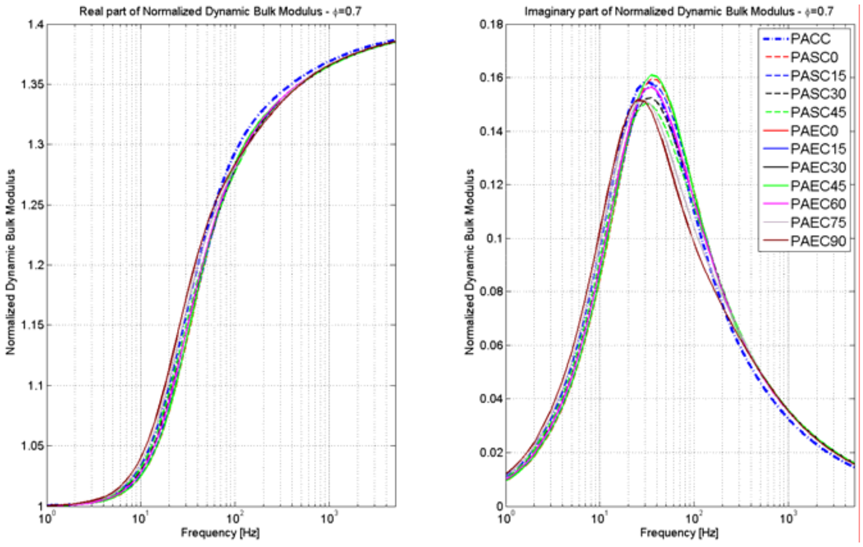

Fig A.2 Normalized Dynamic Bulk Modulus ($\phi = 0.7$).

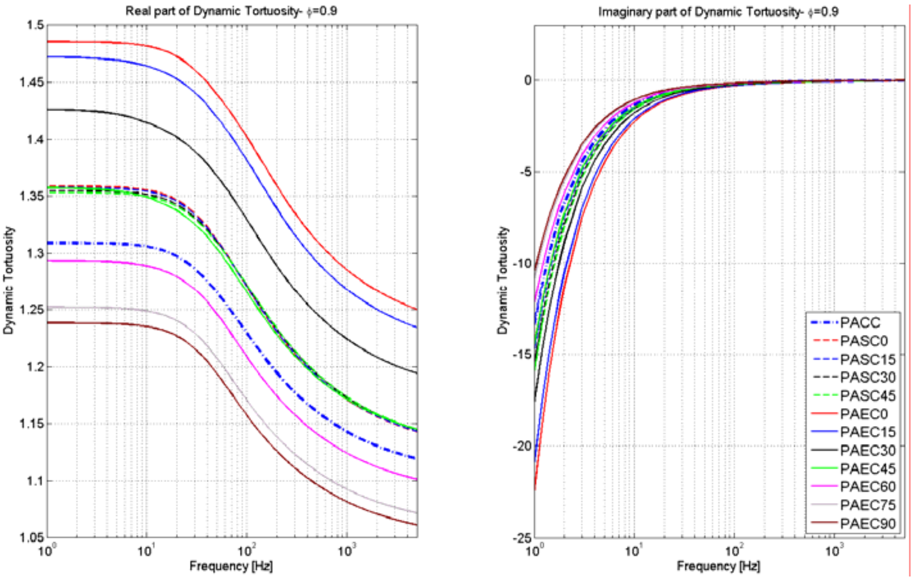

Fig A.3 Dynamic tortuosity ($\phi = 0.9$).

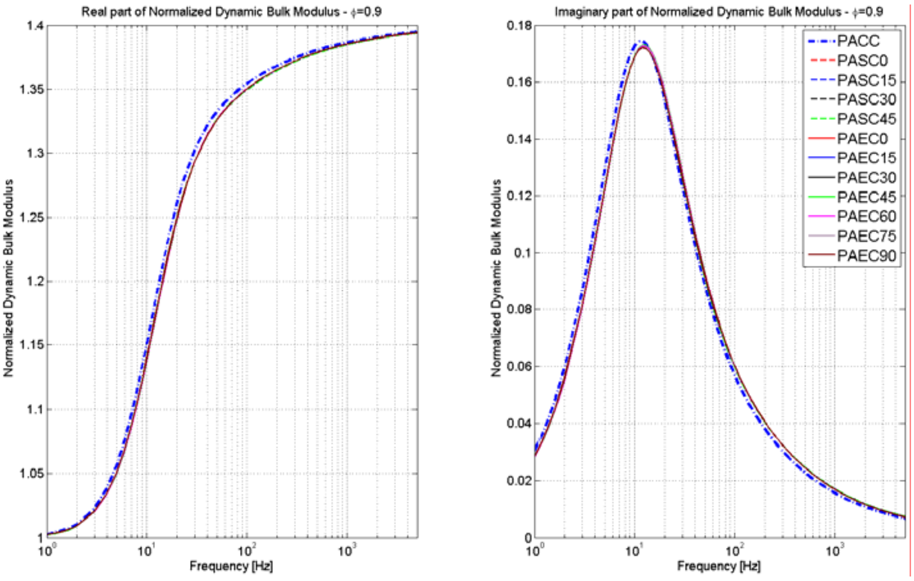

Fig A.4. Normalized Dynamic Bulk Modulus ($\phi = 0.9$).

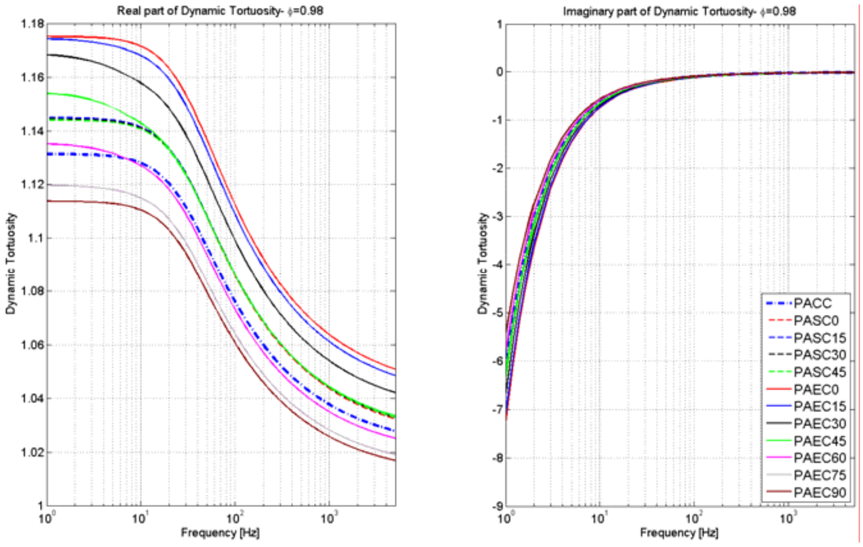

Fig A.5 Dynamic tortuosity ($\phi = 0.98$).

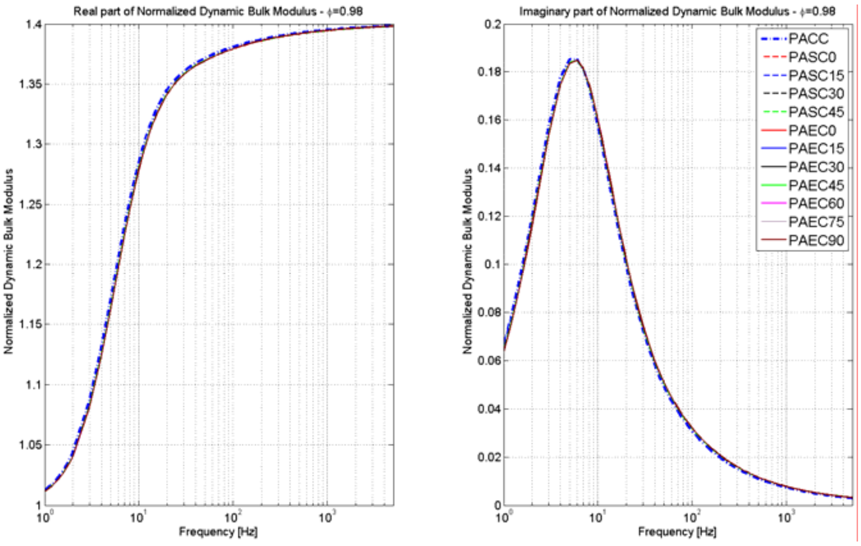

Fig A.6 Normalized Dynamic Bulk Modulus ($\phi = 0.98$).

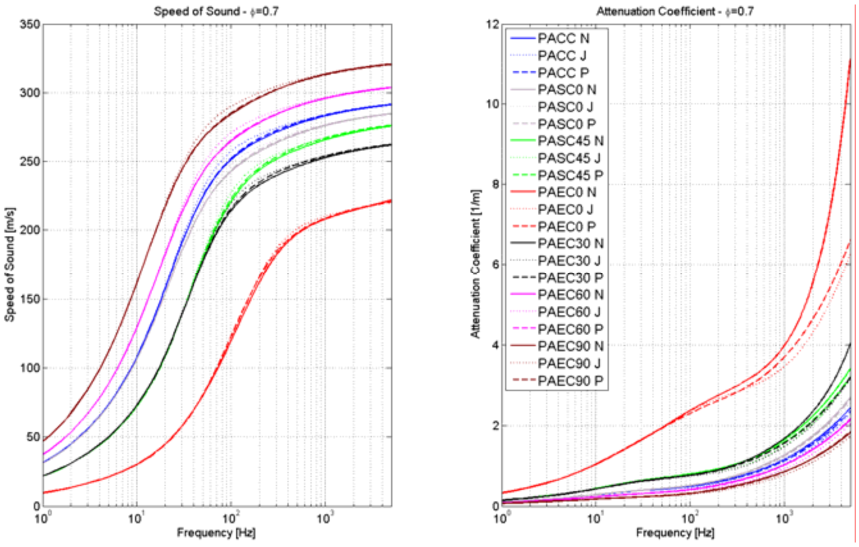

Fig A.7 Speed of sound and attenuation coefficient ($\phi = 0.7$).

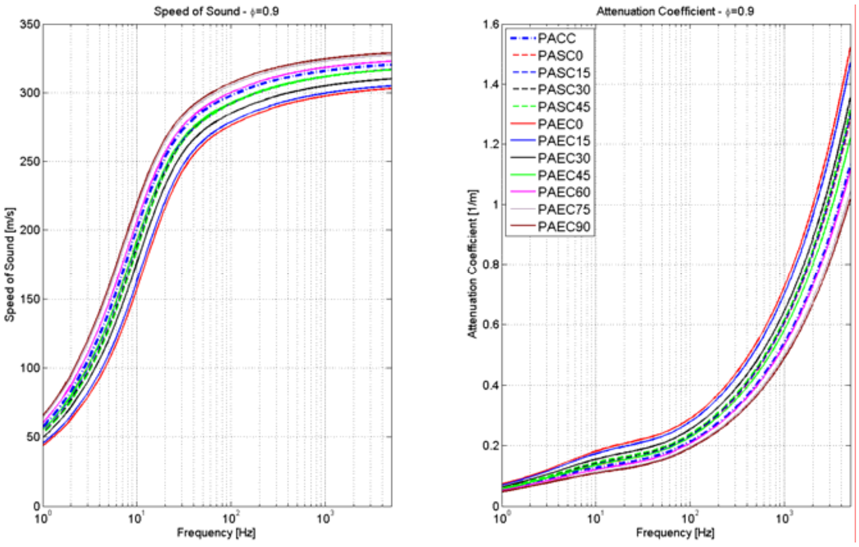

Fig A.8 Speed of sound and attenuation coefficient ($\phi = 0.9$).

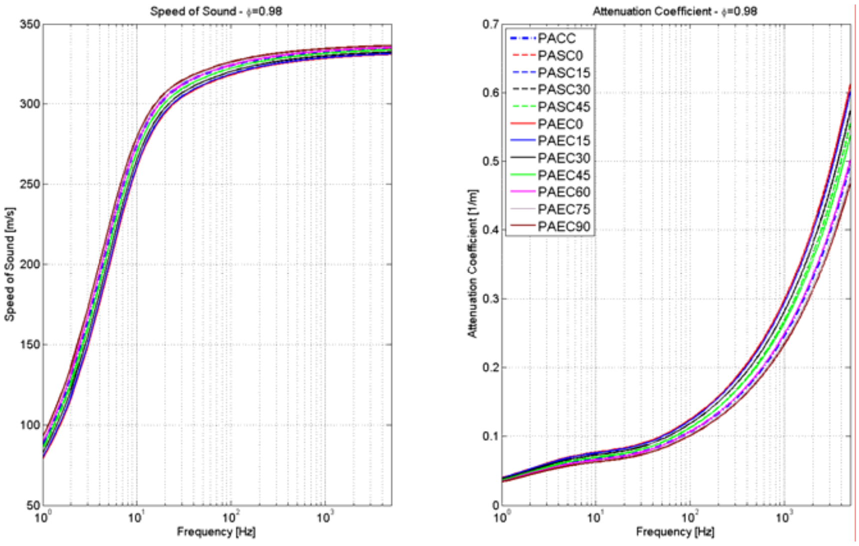

Fig A.9 Speed of sound and attenuation coefficient ($\phi = 0.98$).

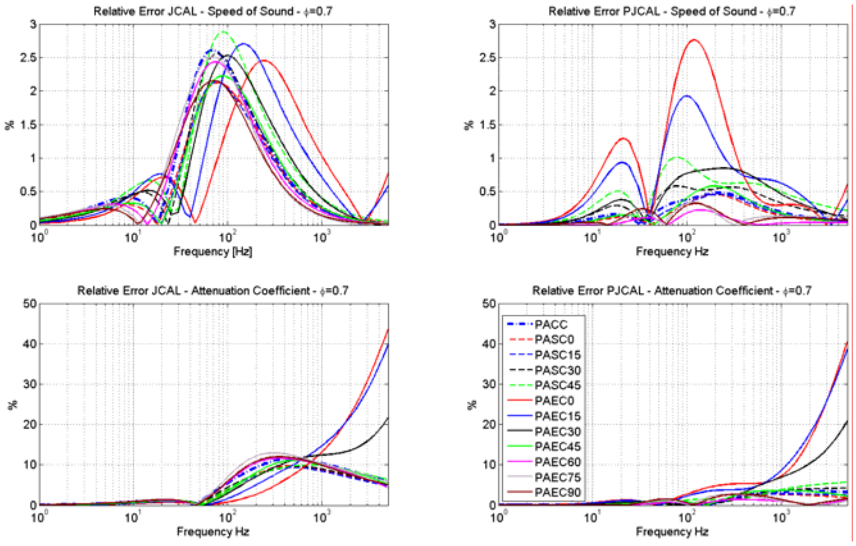

Fig. A.10 Relative Error of speed of sound and attenuation coefficient: JCAL and PJCAL ($\phi = 0.7$)

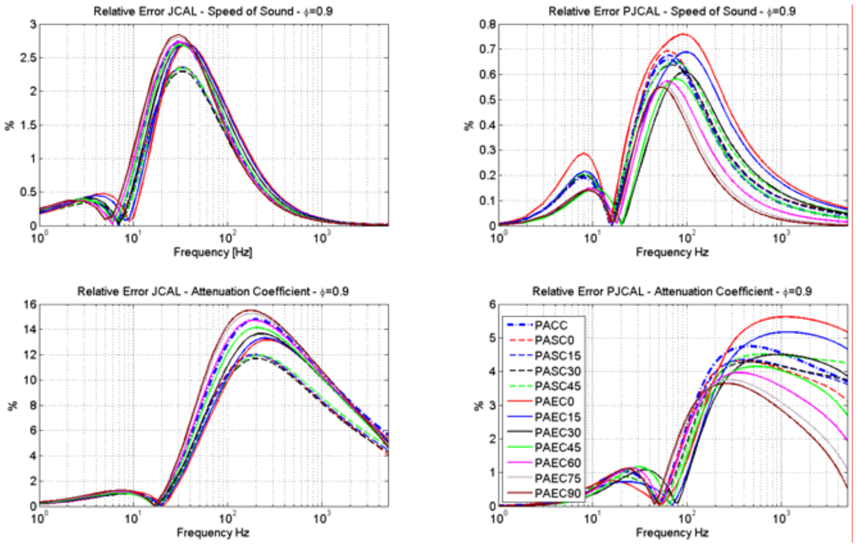

Fig. A.11 Relative Error of speed of sound and attenuation coefficient: JCAL and PJCAL ($\phi = 0.9$)

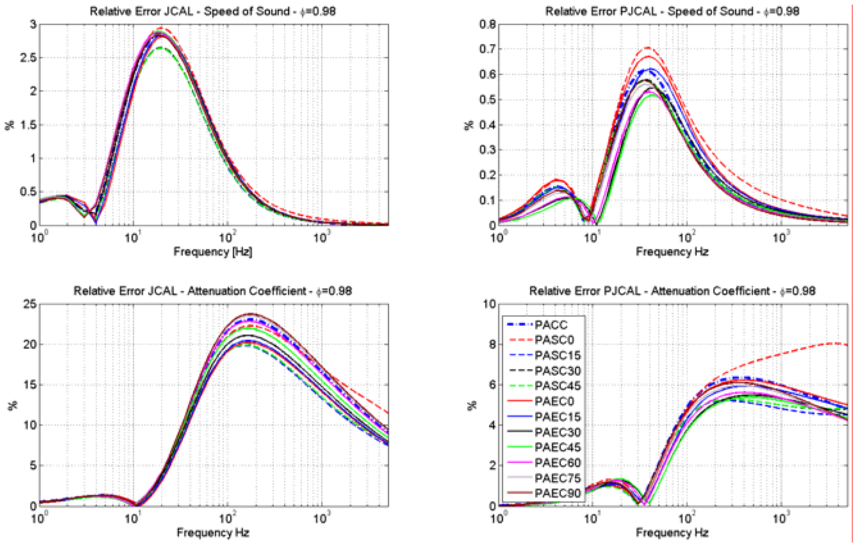

Fig. A.12 Relative Error of speed of sound and attenuation coefficient: JCAL and PJCAL ($\phi = 0.98$)

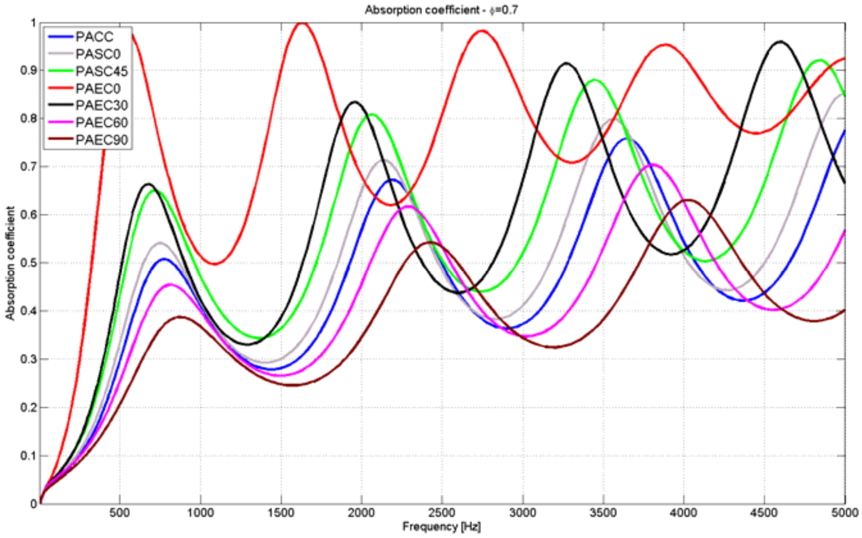

Fig.A.13 Absorption coefficient ($\phi = 0.7$)

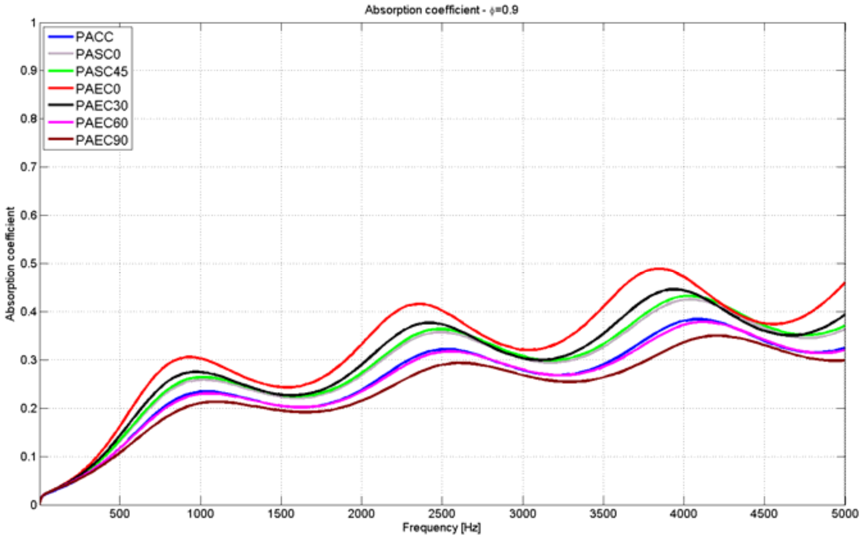

Fig.A.14 Absorption coefficient ($\phi = 0.9$)

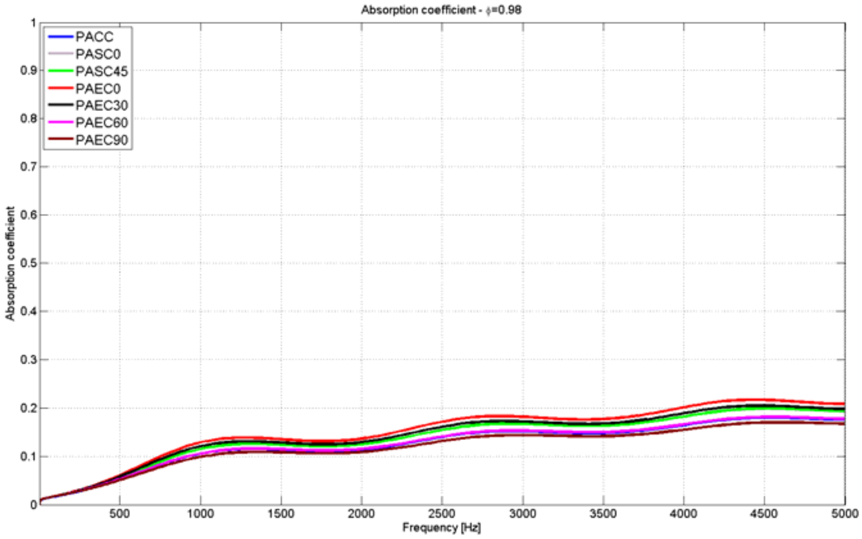

Fig.A.15 Absorption coefficient ($\phi = 0.98$)