Polymethyl methacrylate (PMMA)

1) $P_{11} = 0.121$

$P_{12} = 0.27$

$\varepsilon_r = 2.481 \times 10^{-5}$

$\varepsilon_z = 8.598 \times 10^{-6}$

$n = 1.46$

$P = 2\,MPa$

$$\frac{\Delta\phi}{\phi} = \varepsilon_z - \frac{n^2}{2}\left[(P_{11}+P_{12})\varepsilon_r + P_{12}\varepsilon_z\right]$$

$$= (8.598\times10^{-6}) - \frac{1.46^2}{2}\left[(0.121+0.27)2.481\times10^{-5} + (0.27\times8.598\times10^{-6})\right]$$

$$= 4.215\times10^{-6}\times\pi \text{ radian}$$

We have $\phi = 1.54\times10^{7}$ rad.

$\Delta\phi = 1.1329$ rad.

$$S_m = \frac{\Delta\phi}{P} = \frac{1.1329}{2} = 0.5664$$

$$S_{(dB)} = 20\log(S_m/S_r) = 20\log(0.5664\times10^{-6}) = -124.937\,dB.$$

2) For $P = 3\,MPa$.

$\varepsilon_r = 3.72\times10^{-5}$

$\varepsilon_z = 1.29\times10^{-5}$

$\Delta\phi = 1.6972$ radian.

$S_m = 0.5657$

$S_{(dB)} = -124.947\,dB.$

3) For $P = 1\,MPa$

$\varepsilon_r = 1.24\times10^{-5}$

$\varepsilon_z = 4.30\times10^{-6}$

$\Delta\phi = 0.5657$ radian

$S_m = 0.5657$

$S_{(dB)} = -124.947\,dB.$

Polyurethane

1) $P_{11} = 0.121$

$P_{12} = 0.27$

$\varepsilon_r = 1.34 \times 10^{-3}$

$\varepsilon_z = 5.95 \times 10^{-4}$

$n = 1.46$

$P = 2\,MPa$

$$\frac{\Delta\phi}{0} = \varepsilon_z - \frac{n^2}{2}\left[(P_{11}+P_{12})\varepsilon_r + P_{12}\varepsilon_z\right]$$

$$= (5.95\times10^{-4}) - \frac{(1.46)^2}{2}\left[(0.121+0.27)1.34\times10^{-3} + 0.27\times5.95\times10^{-4}\right]$$

$$= 1.346\times10^{-4}\times\pi \text{ radian}$$

We have $\phi = 1.54\times\frac{180}{10^{-7}}$ rad

$\Delta\phi = 36.18$ radian

$$S_m = \frac{\Delta\phi}{P} = 18.093$$

$$S(dB) = 20\log\left(\frac{S_m}{S_r}\right) = 20\log(18.093\times10^{-6})$$

$$= -94.849\ dB.$$

2) For $P = 3\,MPa$

$\varepsilon_r = 2\times10^{-3}$

$\varepsilon_z = 8.93\times10^{-4}$

$\Delta\phi = $ ~~133.007~~ 53.52

$S_m = 17.842$

$S(dB) = -94.9710\ dB.$

3) For $P = 1\,MPa$.

$\varepsilon_r = 6.68\times10^{-4}$

$\varepsilon_z = 2.98\times10^{-4}$

$\Delta\phi = 17.841$

$S_m = 17.841$

$S(dB) = -94.9714\ dB.$

Silicon rubber

1) $P_{11} = 0.121$

$P_{12} = 0.27$

$\varepsilon_r = 3.47 \times 10^{-2}$

$\varepsilon_z = 1.62 \times 10^{-2}$

$n = 1.46$

$P = 2\,MPa$

$$\frac{\Delta\phi}{\phi} = \varepsilon_z - \frac{n^2}{2}\left[(P_{11}+P_{12})\varepsilon_r + P_{12}\varepsilon_z\right]$$

$$= 1.62\times10^{-2} - \frac{1.46^2}{2}\left[(0.121+0.27)3.47\times10^{-2} + 0.27\times1.62\times10^{-2}\right]$$

$$= 2.9277\times10^{-3} \times \frac{\pi}{180}\ rad.$$

We have $\phi = 1.54\times10^{7}$ rad

$\Delta\phi = 786.92$ rad.

$S_m = 393.46$

$S_{(dB)} = 20\log\left(\frac{S_m}{S_r}\right) = -68.101\ dB$ //

2) For $P = 3\,MPa$.

$\varepsilon_r = 5.21\times10^{-2}$

$\varepsilon_z = 2.43\times10^{-2}$

$\Delta\phi = 1193.792$ rad.

$S_m = 397.930.$

$S_{(dB)} = -68.003\ dB.$ //

3) For $P = 1\,MPa$

$\varepsilon_r = 1.74\times10^{-2}$ ~~8.08×10^{-3}~~

$\varepsilon_z = 8.08\times10^{-3}$

$\Delta\phi = 397.918$

$S_m = 397.918$

$S_{(dB)} = -68.0041\ dB.$ //