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Leading Innovation

Cryogel Phantoms for Ultrasound Elastography

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Sources

Scientific literature

- Chu KC, Rutt BK. *Polyvinyl alcohol cryogel: an ideal phantom material for MR studies of arterial flow and elasticity*. Magn Reson Med. 1997; 37(2):314-9

- Brusseau E. *Local estimation of the RF signal compression for ultrasound elastograhy. Application to intravascular ultrasound imaging*. PhD Thesis, National Institute of Applied Sciences (INSA, Lyon, France). 2000; pp. 114-121

- Brusseau E, Fromageau J, Rognin NG, Delachartre P, Vray D. *Investigating elastic properties of soft biological tissues*. IEEE Eng Med Biol Mag. 2002; 21(4):86-94

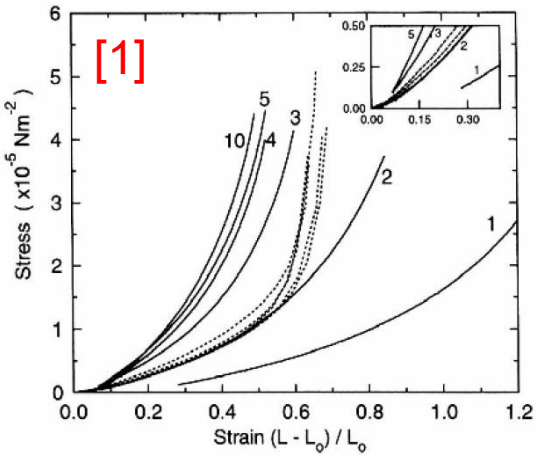
- Rognin NG, Mérel C, Cachard C, Brusseau B, Finet G. *Ultrasound contrast agent in intravascular echography: parametric mapping based on RF output*. Proc IEEE Ultrasonics Symp. 2000, pp. 1787-1790

- Fromageau J, Gennisson JL, Schmitt C, Maurice RL, Mongrain R, Cloutier G. *Estimation of polyvinyl alcohol cryogel mechanical properties with four ultrasound elastography methods and comparison with gold standard testings*. IEEE Trans Ultrason Ferroelectr Freq Control. 2007; 54(3):498-509

Specifications

- Phantom
  - Material: PolyVinyl Alcohol Cryogel (PVA-C)
    - Acquire mechanical properties by a freeze-thaw process
    - Stiffness increases with
      - concentration of PVA solution (10 - 15% in water)
      - number of freeze-thaw cycles (-20°C and +20°C, 8 hours)
    - Echogenicity
      - 1% of acoustical scatters → Silicon–Carbide (SiC, Ø=15 µm)

- PVA (15%)
-- porcine aorta



E = 175 kPa (porcine aorta)
E = 190 kPa (PVA, 2 cycles)

- Acoustic & mechanical properties
  - Within the range of soft biological tissues

[1]

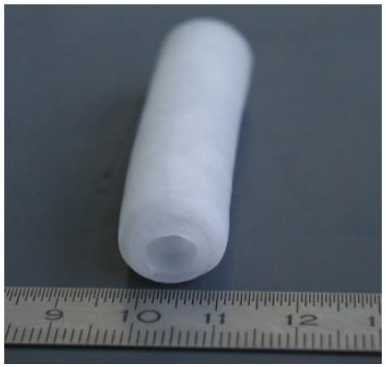
Sound velocity	[1540 m/s - 1580 m/s]
density	1.03 g/cm^3
Attenuation factor	3.0 dB/cm at 5 MHz
Acoustic impedance	1,600,000 kg/m²/s
Elastic modulus	[1 kPa - 1000 kPa]

[1] Chu KC, Rutt BK. *Polyvinyl alcohol cryogel: an ideal phantom material for MR studies of arterial flow and elasticity*. Magn Reson Med. 1997; 37(2):314-9.

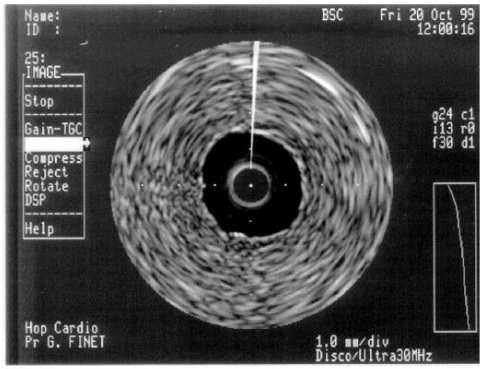
Applications

- **Quasi-Static Elastography: IntraVascular UltraSound (IVUS)**
  - Two-layer cryogel phantom
    - Inner layer = 1 freeze-thaw cycle (soft), Outer layer = 3 freeze-thaw cycles (hard)

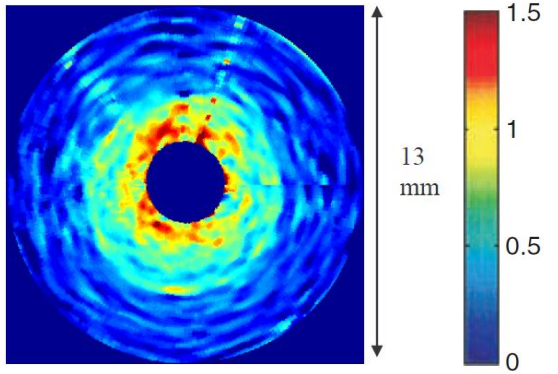
[2-3]



(a) Photograph of the two-layer phantom



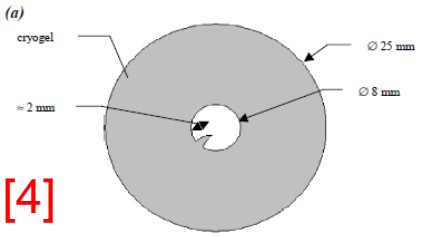
(b) Video image of the phantom

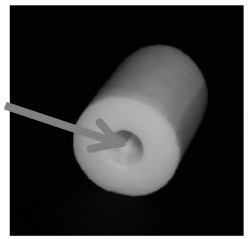


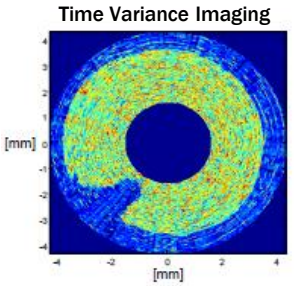
(c) Elastogram in cartesian coordinates

- **Contrast imaging: IVUS**
  - Atheromatous plaque
  - Segmentation

[4]



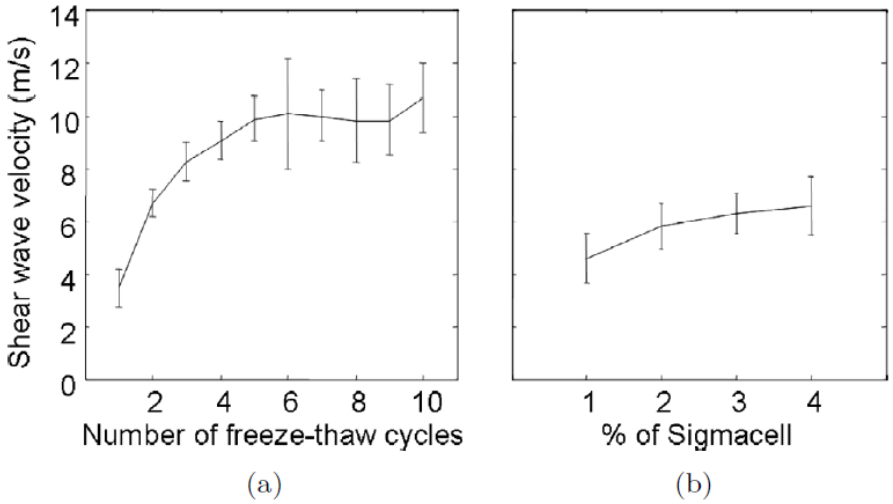




[2] Brusseau E, Fromageau J, Rognin NG, Delachartre P, Vray D. *Investigating elastic properties of soft biological tissues*. IEEE Eng Med Biol Mag. 2002; 21(4):86-94
[3] Brusseau E. *Local estimation of the RF signal compression for ultrasound elastograhy. Application to intravascular ultrasound imaging*. PhD Thesis, National Institute of Applied Sciences (INSA, Lyon, France). 2000; pp. 114-121
[4] Rognin NG, Mérel C, Cachard C, Brusseau B, Finet G. *Ultrasound contrast agent in intravascular echography: parametric mapping based on RF output*. Proc IEEE Ultrasonics Symp. 2000; pp. 1787-1790

Applications

- **Shear Wave Elastography**
  - **Solution**
    - **10% of PVA-C dissolved in pure water and ethanol homopolymer**
    - **1 - 4 % of acoustical scatters → Sigmacell Cellulose particles (Ø = 20 µm)**



[5]

Fig. 5. Shear wave speed in PVA samples. (a) As a function of the number of freezing-thawing cycles for 3% Sigmacell. (b) As a function of the percentage of Sigmacell for two freezing-thawing cycles.

[5] Fromageau J, Gennisson JL, Schmitt C, Maurice RL, Mongrain R, Cloutier G. *Estimation of polyvinyl alcohol cryogel mechanical properties with four ultrasound elastography methods and comparison with gold standard testings*. IEEE Trans Ultrason Ferroelectr Freq Control. 2007; 54(3):498-509

Thank you for your attention