

温度表示機能を有する手術トレーニング用臓器モデル



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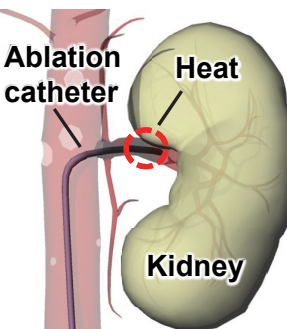
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加熱温度が色で分かるハイドロゲル血管モデル

Background

Catheter ablation



Cure high blood pressure

Ablation of sympathetic nerve

Target : 60 °C

Possibility of overheat

Surgical simulator with temperature sensor

Previous study & Purpose



Room temp.



90 °C

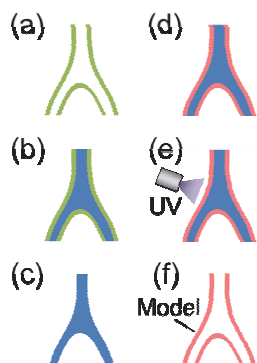
- ✓ Silicone rubber composition
- ✓ Irreversible color change
- ✓ Similarity of thermal conductivity to human tissue (0.27 mW/mk)

Silicone rubber Hydrogel

	Silicone rubber	Hydrogel
Young's modulus	○	○
Thermal conductivity	○	○
Electrical conductivity	△	○
Friction property	×	○

- ✓ **Hydrogel composition**
- ✓ **Visualization of temperature distribution on the model**

Fabrication process



(a) Make a resin vessel model by 3D printer

(b) Form gelatin mold

(c) Remove resin model

(d) Coat with material

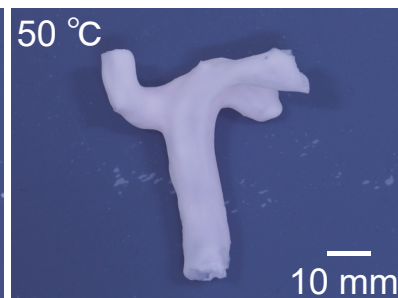
(e) UV-exposure to crosslink hydrogel material

Repeat (d),(e) 10 times

(f) Remove gelatin mold by water



35 °C

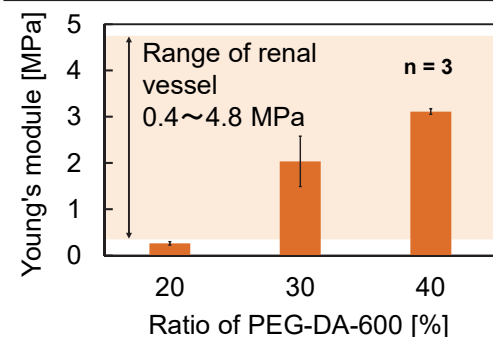


50 °C

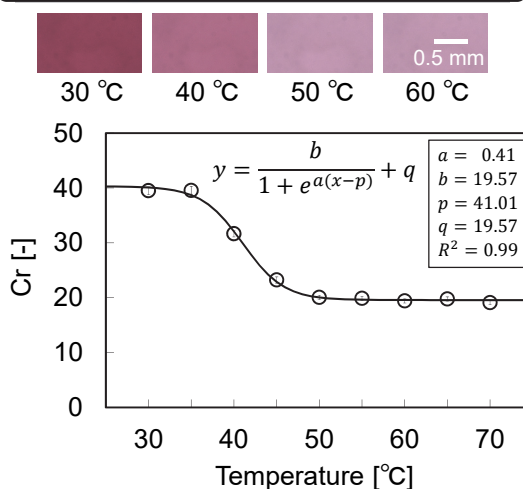
10 mm

Similarity of young's modulus

PEG-DA600 [ml]	10% PVA417 [ml]	50% Chromicloro ₂ [ml]	Irgacure 1173 [ml]
20	90	2	2
40	90	2	2
60	90	2	2



Temperature calibration



Condition

Sample thickness : 1.4 mm
 Light : Halogen lamp
 (Color temperature : 3000 K)
 Microscope : MZ16 F
 CCD : GS3-U3-23S6C-C

Convert RGB to Cr

$$Cr = 0.5R - 0.419G - 0.081B$$

※Cr : Color difference of red

Resolution :

±1.0 °C (35~50 °C)

Conclusion

- Succeeded in fabricating hydrogel 3D vessel model with temperature responsive function
- Controllability of Young's modulus with PEG ratio : **0.3 - 3.2 MPa**
- Resolution of the temperature measurement : **±1.0 °C (from 35 to 50 °C)**

