

熱損傷評価のための温度応答型三次元血管モデル



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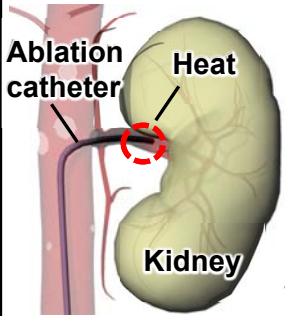


焼灼手術の到達温度を可視化するには？

Background

Catheter ablation

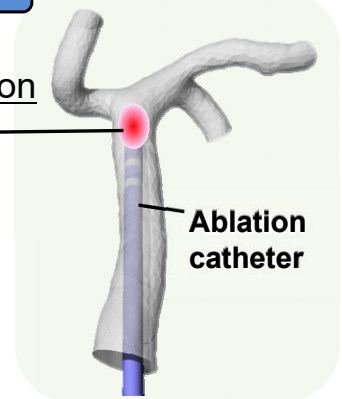
Cure high blood pressure
 Ablation of sympathetic nerve
 Target : 60 °C
 Possibility of **overheat**
 Surgical simulator with temperature sensor



Purpose & Concept

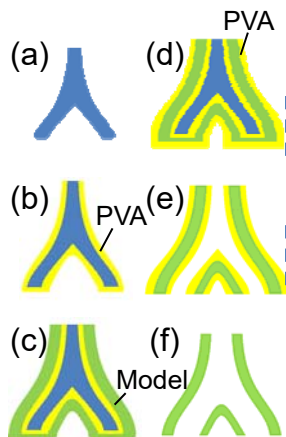
Renal vessel model with temperature responsive function

Heat
 Color change
 ✓ Visualization of temperature distribution inside the model
 ✓ Sensing without wiring



Fabrication process

- (a) Make a wax pattern by 3ZPRO (SolidScape)
 (b) Coat with PVA* 4 times to protect model from acetone
 (c) Coat with model material 6 times
 (d) Coat with PVA 4 times to protect model from acetone
 (e) Remove wax pattern by acetone
 (f) Remove PVA by water
- *Polyvinyl alcohol



Experiment

Confirm how PVA thickness is required to protect from acetone

Temp. \ PVA	23 μm	47 μm
Room Temp.		
90 °C		

Over 47 μm PVA to protect from acetone



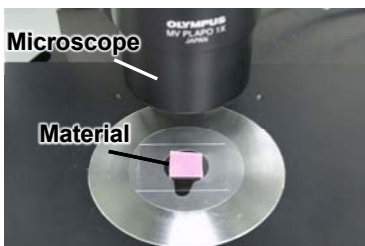
Heated model (at 90 °C)

Material & Method

- ✓ Polydimethyl siloxane
- thermal conductivity : 0.27 W/mK (Muscle : 0.3 W/mK)
- ✓ Thermochromic dye 2 wt%
- Color changes over 75 °C
- irreversible



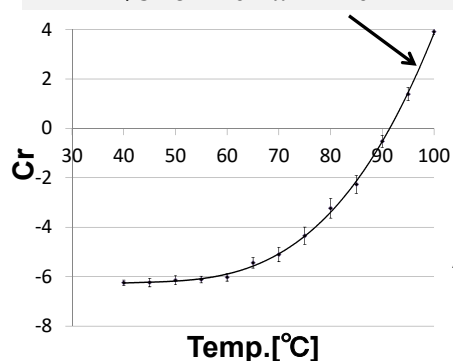
Room temp. 90 °C



Get the RGB value of the heated material
 And convert to temperature

Temperature calibration

Temp. [°C]	40 °C	60 °C	80 °C	100 °C
Cr	30	40	50	60



Condition

Sample thickness : 1.5 mm
 Light : Halogen lamp (532 nm wavelength : 0.03 mW)
 Microscope : MVX10
 CCD : WAT-250D2

Convert RGB to Cr

※Cr : Color difference of red

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

Accuracy : -3.5 ~ +2.4 °C

Precision : ±3.1 °C (60 ~ 100 °C)

Conclusion

Succeeded in fabricating 3D vessel model with temperature responsive function

Accuracy of the temperature measurement: -3.5/+2.4 °C Precision : ±3.1 °C (from 60 to 100 °C)

Reference:

渡邊貴文, 丸山央峰, 早川健, 新井史人, 池田誠一, 熱損傷評価のための温度応答型三次元血管モデル, ロボティクス・メカトロニクス講演会2016, 1A2-02b7, 2016

Acknowledgements:

本研究は, 内閣府戦略的イノベーション創造プログラム(SIP)の研究課題「イノベーション・サエティを活用した中部発革新的機器製造技術」の助成を受けて行われたものである。

