

Blood-mimicking Dye Phantoms for Evaluating Photoacoustic Imaging Devices

User Manual

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User Manual v1.0

Introduction

This document describes fabrication materials and methods for constructing blood-mimicking phantoms using near-infrared organic dyes (NIR746A and IRA980).

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Recipes

The detailed concentration, the specific volume of each dye stock solution, and add-in volume of ethylene glycol were listed in the table below.

sO₂ (%)	0.01 mg/mL NIR746A solution (mL)	0.02 mg/mL IRA980 solution (mL)	Ethylene glycol (mL)
100	0.2	19.1	0.7
90	0.8	17.7	1.5
80	1.6	16.3	2.1
70	2.4	14.7	2.9
60	3.6	13.2	3.2
50	4.4	11.8	3.8
40	5	10.5	4.5

Materials/Chemicals

Item	Amount	Supplier	Product name/Number	Link
NIR746A	30 mg	QCR Solution Corp.	NIR746A	link
IRA980	30 mg	Luxottica Exciton	IRA980	link
Ethylene glycol	320 mL	Sigma-Aldrich	324558	link

Equipment/Supplies

1. Adjustable pipettor (0.1-1 mL, QU14866, Fisherbrand)
2. Anti-static weighing paper (09-898-12B, Fisher Scientific)
3. Mass balance (BCE124-1S, Sartorius)

4. Plastic and glass liquid storage bottle
5. Scale (V11p6, Ohaus)
6. Scoopula (Fisher Scientific)
7. Ultrasonic bath (08895-05, Cole-Parmer)

Dye Preparation Protocol

1. Use the mass balance to weigh 30 mg of NIR746A: put a weighing paper on the balance, zero out the reading, and add 30 mg of NIR746A. Make sure to weigh the residual after removing NIR746A to estimate the error.
2. Use the scale to prepare 150 mL ethylene glycol: put a plastic bottle on the scale, zero out the reading, and add 167.0 g (150 mL) ethylene glycol. Assume the density of ethylene glycol is 1.113 g/mL.
3. Dissolve the 30 mg NIR746A in the 150 mL ethylene glycol to form 0.2 mg/mL solution in the bottle.
4. Sonicate solutions for at least 30 minutes until homogenous.
5. Repeat steps 1-4 for IRA980 to get 0.2 mg/mL IRA980 solution.
6. Dilute 0.2 mg/mL NIR746A solution to 0.01 mg/mL by mixing 5 mL 0.2 mg/mL solution with 95 mL ethylene glycol. The 0.01 mg/mL NIR746A solution serves as stock solutions for preparing dye mixtures with different sO₂ values. The mixing process is done by first putting a plastic bottle on the mass balance, resetting weight to 0, then adding 5.566 g 0.2 mg/mL solution, and at last adding 105.754 g ethylene glycol.
7. Dilute 0.2 mg/mL IRA980 solution to 0.02 mg/mL by mixing 10 mL 0.2 mg/mL solution with 90 mL ethylene glycol. The 0.02 mg/mL IRA980 solution serves as stock solutions for preparing dye mixtures with different sO₂ values. The mixing process is done by first putting a plastic bottle on the mass balance, resetting weight to 0, then adding 11.132 g 0.2 mg/mL solution, and at last adding 100.188 g ethylene glycol.
8. To make 20 mL 100% sO₂ solution, first put a glass bottle on the scale, reset weight to 0, then add 0.223 g 0.01 mg/mL dye 746a solution, then add 21.262 g 0.02 mg/mL dye 980 solution, and at last add 0.779 g ethylene glycol.
9. To make 20 mL 90% sO₂ solution, first put a glass bottle on the scale, reset weight to 0, then add 0.891 g 0.01 mg/mL dye 746a solution, then add 19.704 g 0.02 mg/mL dye 980 solution, and at last add 1.670 g ethylene glycol.
10. To make 20 mL 80% sO₂ solution, first put a glass bottle on the scale, reset weight to 0, then add 1.781 g 0.01 mg/mL dye 746a solution, then add 18.145 g 0.02 mg/mL dye 980 solution, and at last add 2.338 g ethylene glycol.
11. To make 20 mL 70% sO₂ solution, first put a glass bottle on the scale, reset weight to 0, then add 2.672 g 0.01 mg/mL dye 746a solution, then add 16.364 g 0.02 mg/mL dye 980 solution, and at last add 3.228 g ethylene glycol.

12. To make 20 mL 60% sO₂ solution, first put a glass bottle on the scale, reset weight to 0, then add 4.008 g 0.01 mg/mL dye 746a solution, then add 14.694 g 0.02 mg/mL dye 980 solution, and at last add 3.562 g ethylene glycol.

13. To make 20 mL 50% sO₂ solution, first put a glass bottle on the scale, reset weight to 0, then add 4.899 g 0.01 mg/mL dye 746a solution, then add 13.136 g 0.02 mg/mL dye 980 solution, and at last add 4.230 g ethylene glycol.

14. To make 20 mL 40% sO₂ solution, first put a glass bottle on the scale, reset weight to 0, then add 5.566 g 0.01 mg/mL dye 746a solution, then add 11.689 g 0.02 mg/mL dye 980 solution, and at last add 5.010 g ethylene glycol.

15. Store prepared solutions in a dark location with closed cap.

Once dye solutions are prepared, they may be injected into a tissue-mimicking phantom to provide contrast under photoacoustic imaging [1].

References

- Zhou, Y., Wang, Z., Wear, K. A., Pfefer, T. J., Jokerst, J. V., Vogt, W. C., “Blood-mimicking Dye Phantoms for Evaluating Photoacoustic Oximetry Accuracy”, *Photoacoustics* 47, 100795, 2026, <https://doi.org/10.1016/j.pacs.2026.100795>