Electrically Modulated Optical Phantoms for Mimicking In Vivo Hemodynamics of Layered Tissue

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Optical phantoms are synthetic materials that simulate tissue optical properties. They are commonly used in imaging system calibration and testing. However, optical phantoms are typically static and cannot recapitulate in vivo tissue hemodynamics. Here we develop new methods to create rigid multi-layered silicone optical phantoms with varying layer thicknesses. We then incorporated the use of a reflective LCD in tandem with the multilayered optical phantoms to mimic tissue hemodynamics. This electro-optical device changes the contrast setting of the LCD by changing the control voltage. Different contrast settings reflect and absorb different amounts of light which effectively changes the optical properties of the phantom. We measured a participant's chromophore values during a cuff occlusion in order to evaluate the validity and repetitively of the electro-optical phantom. The thickness of the multilayered phantom was determined via ultrasound on the arm. Then, using calibration curves acquired by a diffuse optical spectroscopy system and our electro-optical phantom, we calculated the LCD settings required to recreate the change in chromophore values from the participant's measurements. We then recreated the chromophore curve using our multilayered electro-optical phantoms and the LCD settings we calculated. Finally, to further expand the capability of our phantoms, we tested different methods to incorporate new hydrophobic absorbing dyes. These dyes can expand the versatility of optical phantoms to the shortwave infrared (SWIR) wavelength region. These developments represent a major step forward in the development of dynamic optical phantoms for the biophotonics community.