

Tissue-Mimicking Polymer Test Phantoms for Optical-Acoustic Medical Imaging

Technology Summary

Photoacoustic Imaging (PAI) is a technology that combines pulsed laser irradiation with acoustic sensing to provide deep and/or high resolution medical-grade images of tissue structure, pathology, and function. Exemplary PAI applications include vascular imaging, cancer detection, and mammography. While PAI is rapidly emerging as a clinically viable approach with wide applicability, there are currently no standard methods to evaluate PAI device performance or image quality. As with many medical imaging modalities, tissue-mimicking phantoms can form the basis of image quality test methods for PAI. While previous phantoms used for PAI systems can adequately mimic the optical or acoustic properties of tissue, none accurately mimic both sets of properties.

The subject invention provides novel poly(vinyl chloride) plastisol (PVCP) formulations that have optical and acoustic properties that can be independently tuned to simulate a range of tissue types. These novel PVCP formulations can be molded into a phantom that mimics the morphology of a specific anatomical body region, part, organ, or a small mammal, as well as its optical and acoustic properties. Alternately, PVCP can be molded into simple geometric forms (e.g. cuboid, cylinder) to produce phantoms with physical properties that are generally representative of biological tissues and can serve as tools for standardized performance testing of PAT devices. When fabricated with well-defined inclusions (e.g., filaments, channels), these phantoms can be used to quantitatively characterize various aspects of PAI system performance (e.g., spatial resolution, signal uniformity, penetration depth, etc.). Key applications of such phantoms include medical device development, design optimization and preclinical validation, system inter-comparison, standardization of multi-institutional clinical trials, manufacturing quality control, constancy testing and routine calibration and repair.

Potential Commercial Applications

- PVCP phantoms that provide high-fidelity tools for evaluating the image quality and the performance of clinical PAI systems.
- PVCP phantoms that can mimic the optical and acoustic properties, as well as the morphology, of a range of tissue types, organs and small mammals.
- As easy-to-use tools to test acoustic, photoacoustic, opto-acoustic and acousto-optical technologies for imaging and sensing, or multi-modal devices.
- As education tools to train users how to operate an optical/acoustic detection system.

Competitive Advantages

- Distinct from other photoacoustic and PVCP phantoms, the formulations of this technology can be used to create tunable phantoms (sound speeds of 1400-1520 m/s) with low acoustic attenuation and scattering that mimic tissue-relevant properties and behavior.
- Allows for independent tuning of mechanical/acoustic properties from optical properties.
- Offers higher mechanical strength and longer shelf life compared to hydrogel-based phantoms.

Development Stage: Early Stage, Prototype

Inventors: Thomas Pfefer, William Vogt, Congxian Jia

Publication(s): "Biologically relevant photoacoustic imaging phantoms with tunable optical and acoustic properties." J Biomed Opt. 2016 Oct;21(10):101405. PMID 26886681.

Intellectual Property: US Patent 9,920,188 issued 3/20/2018

FDA Reference: E-2016-003

Licensing Contact:

FDA Technology Transfer Program

Email: FDAInventionLicensing@fda.hhs.gov