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Editorial

# "Contrast agents for optoacoustic imaging: design and biomedical applications"

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ABSTRACT

Nanoparticles and molecular chromophores with strong optical absorption in the near-infrared spectral range can be used as contrast agents for optoacoustic (photoacoustic) imaging, thereby significantly enhancing sensitivity and enabling new applications of this novel and rapidly growing biomedical imaging technology.



Optoacoustic Tomography (OAT) emerged in early 1990s as a new biomedical imaging technology that generates images by illuminating tissues with laser pulses and detecting resulting ultrasound waves [1,2]. OAT takes advantage of spectroscopic approach to molecular imaging, and delivers high-resolution images in the depth of tissue. Resolution of the optoacoustic imaging is scalable, so that biomedical systems from cellular organelles to large organs can be visualized and, more importantly, characterized based on their optical absorption coefficient [3]. OAT was shown useful in both, preclinical research using small animal models and clinical applications [4–10]. Applications in the field of molecular imaging offer abundant opportunities for the development of highly specific and effective contrast agents for biomedical optoacoustic imaging [11–13]. Advances in the area of plasmonic nanotechnology opened such opportunities for development of nanoparticle based contrast agents with exceptionally strong absorption in the near-infrared (NIR) spectral range for preclinical applications of optical and optoacoustic imaging [14]. The use of plasmon resonance absorption in metal nanoparticles has been invoked for a diverse range of *in vivo* and *in vitro* applications including imaging and monitoring of tissue, sensing of molecules, cells and harmful microorganisms [15–17] as well as selective optothermal therapy [18,19]. The very recent efforts are being made in the direction of nontoxic biodegradable contrast agents (such as nanoparticles made of biopolymers, melanin and indocyanine green) potentially applicable in clinical optoacoustic imaging [20–22]. It is noteworthy that molecular contrast agents being developed for optical imaging modalities (such as fluorescence imaging) are directly applicable to the optoacoustic imaging [23,24]. Furthermore, optoacoustic contrast agents can be combined with ultrasonic contrast agents for dual modality imaging [25–27]. One area of particular relevance to optoacoustic imaging is the enhancement of malignant tumor contrast relative to background normal tissue [28,29]. Once cancerous lesion is detected, it is only logical to use lasers and/or ultrasound for minimally invasive therapy of cancer [30–32]. Optoacoustic imaging systems can be used for molecular imaging and monitoring physiological processes in preclinical research applications using mouse models of cardiovascular and other diseases [33]. In addition, in combination with reporter genes, these systems offer promise for imaging genetic processes, monitoring the delivery of specific genes to target cells and visualizing the kinetics of therapeutic gene expression [34,35]. In order to increase efficiency and specificity of contrast agents and probes, they can be made smart and capable of controlled accumulation in the target cells [36] or activatable with external electromagnetic energy [37,38]. Recognizing the potential breakthroughs in optoacoustic imaging that can be achieved using variety of technological advances made in the past decade in the field of optical, optoacoustic and ultrasonic contrast agents, we invited the biomedical optics community and biomedical ultrasound community to join the bionanotechnology community and the optoacoustic imaging and sensing community by contributing to this special issue of Photoacoustics dedicated to contrast agents and their biomedical applications.

Alexander Oraevsky
Guest Editor

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