Photoacoustic imaging is an emerging, simple, low cost, non-ionizing and non-invasive technology that holds promise for diagnostic imaging and therapeutic monitoring of a variety of disease, such as cancer and inflammation. Powered by a variety of optical contrast agents, including metallic or sonophoric nanoparticles, each can be engineered to have unique optical properties and biochemical functions, photoacoustic imaging has been promoted from just a structural imaging technique showing tissue morphological features to one that combines chemical and structural imaging. For the first time, photoacoustic imaging could enable molecular imaging and drug delivery monitoring, and facilitate quantitative evaluation of local chemical properties in tissues, e.g. oxygenation and pH level, both important physiological biomarkers of cancer. In this presentation, we will show you the exciting research findings at University of Michigan, achieved through the close collaboration involving Medical School, Chemistry, and Chemical Engineering. Functional and molecular photoacoustic imaging aided by metallic nanoparticles targeting inflammatory tissues, and by sonophoric nanoparticles containing pH and oxygen sensitive dyes will be demonstrated. We expect that the combination of nanotechnology with novel photoacoustic imaging could lead to reliable early detection, continuous monitoring and optimized treatment of cancer and many other diseases, leading to a significant reduction in both patient suffering and health care cost.