Docket #: S19-309

Metasurface Device for On-Chip Tissue Diagnostics

Inventors at Stanford University have developed a colorimetric device to visualize microstructural features in tissue biopsies towards clinical diagnostics. The geometric arrangement and density of fibrous media, such as collagen fibers, in tissues can be effective quantitative biomarkers for disease, However, these structural markers been clinically underutilized because of a lack of suitable visualization technologies. The invention is a glass chip that is patterned with dielectric nanostructures, in which the spectral shift of visible frequencies is sensitive to the anisotropic properties of the tissue sample with a clinically available microscope. The researchers show that tangential and radial collagen orientations, corresponding localized and metastasized cancer tissues respectively, show distinct color response upon polarized light excitation. Additionally, they demonstrate the predictability of the color changes associated with cancer biopsies in numerical simulations to enable reliable and rapid on-chip tissue diagnostics.

Stage of Development
The authors have experimentally validated and numerically simulated the colorimetric optical response of the device for birefringent tissue biopsies as a proof of concept.

Applications

- Broad clinical applications for disease diagnosis, progression, and risk stratification including cancer, Alzheimer's disease, diabetes

Advantages

- Requires only standard glass coverslip and microscope compared to other techniques that require complex and costly optical tools
- Enables quantitative rapid and cost-effective characterization of biological tissue structures
- Current morphological analyses in clinical biopsies can be subjective and variable

- Molecular or genetic diagnostics are lower-throughput and more costly

Publications

- Poulikakos L.V., Lawrence M., Barton D. R., Jeffry S.S., Dionne J.A. Guided-Mode-Resonant Dielectric Metasurfaces for Colorimetric Imaging of Material Anisotropy in Fibrous Biological Tissue. ACS Photonics 2020, 7, 11, 3216–3227
- Poulikakos L.V., Lawrence M., Barton D. R., Dionne J.A. Functional metasurfaces for rapid, colorimetric cancer tissue diagnostics (Conference Presentation). SPIE BiOS, 2020, San Francisco, California, United States

Patents

- Published Application: 20210088819
- Issued: 11,487,180 (USA)

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