Docket #: S14-086

Nanoscale optical tomography with cathodoluminescence spectroscopy

Stanford researchers have developed a novel tomographic technique, cathodoluminescence (CL) spectroscopic tomography, to probe optical properties in 3D with nanometer-scale spatial and spectral resolution. These tomograms can locate regions of efficient cathodoluminescence across visible and near- infrared wavelengths in three dimensions, with contributions from material luminescence and radiative decay of electromagnetic eigenmodes.
This CL tomography technique has been demonstrated by reconstructing a 3D metal-dielectric metamaterial resonator, illustrating how the technique can be applied to almost any materials system to achieve label-free, nanoscale 3D visualization of light-matter interactions.

Figure

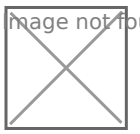

Figure description - SEM CL Set-up

Stage of Research

- **Proof-of-concept** – Successfully demonstrated use of CL tomography to achieve nanoscale 3D visualization of light–matter interactions by reconstructing a three-dimensional metal–dielectric nanoresonator

Applications

- **Photovoltaics,** may enable determination of the 3D distribution of defect states

- **Light emitting diodes** or other semiconductor-based devices, will allow 3D visualization of radiative recombination centers
- **Bio-imaging,** may enable label-free 3D imaging of nanostructures
- **Quantum computing**

Advantages

- **3D Imaging** - Image radiative optical properties with nanoscale spatial and spectral resolution in 3D
- **High resolution** afforded by cathodoluminescence combined with 3D imaging capabilities enabled by tomographic reconstruction
- **Resolution at least 10-100 times better than the diffraction limit**
- **Simple computational methods for reconstruction**
- **Does not require labels** (i.e. fluorescent molecules used in conventional super-resolution biological imaging)
- **Improvements over STEM EELS tomography:**
    - Signal is fundamentally different/complementary
    - Higher spectral resolution
    - SEM -> wider range of samples, cheaper instrumentation

Publications

- Atre, Ashwin C., Benjamin JM Brenny, Toon Coenen, Aitzol García-Etxarri, Albert Polman, and Jennifer A. Dionne. "Nanoscale optical tomography with cathodoluminescence spectroscopy." *Nature nanotechnology* 10, no. 5 (2015): 429-436.

Patents

- Published Application: WO2016007208
- Published Application: 20170052130
- Issued: 10,551,330 (USA)

Innovators

- Ashwin Atre
- Jennifer Dionne
- Benjamin Brenny
- Toon Coenen
- Albert Polman

Licensing Contact

Seth Rodgers

Licensing Manager, Life Sciences

Email