

Research topics for graduate students for 2025

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Department of Mechanical Engineering

Acceptable course(s)

- Master's Degree
- Doctoral Degree



Research Topics

The laboratory specializes in developing functional materials for sensing and energy conversion. Specifically, electromagnetic, optical, and acoustic metamaterials are investigated to address technological issues such as reducing electrical power consumption through optical circuits, sound mitigation, and efficient production of chemical energy sources from solar radiation. Current research topics include the application of metamaterials in chirality sensing, spectrally selective coatings, and photocatalytic materials.

1. Micro/nano fabrication of functional structures [1]

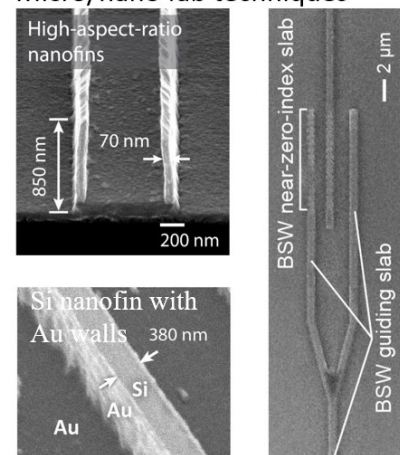
Examples of structures applied in sensing devices and realized by advanced micro/nano fabrication techniques are shown in the right figure.

A surface wave platform with different functionalities such as chiral filtering and optical logic gates is being developed. For this type of optical platform to develop its full potential, microlasers should be integrated into the same platform. These small and micro-integrated coherent light sources are an essential part of the development of optical sensing and communication systems.

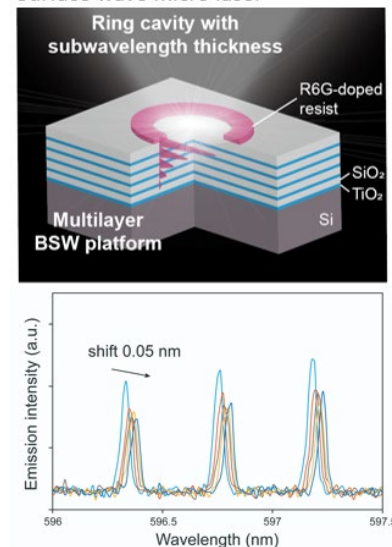
2. Solar energy conversion [2]

Efficient and stable water splitting into hydrogen and oxygen using sunlight is realized using semiconductor nanostructures synthesized by bottom-up techniques and efficient photocatalysts.

Micro/nano fab techniques



Surface wave micro laser



Articles Related to Research Topics

[1] Y.-C. Lee *et al.*, “High-Q lasing via all-dielectric Bloch-surface-wave platform,” *Nature Communications*, 14, 6458, 2023; Z. Wang *et al.*, “Chiroptical response inversion and enhancement of room-temperature exciton-polaritons using two-dimensional chirality in perovskites,” *Advanced Materials*, 2314953, 2023; CZ Deng *et al.*, “Near-Zero-Index Slabs on Bloch Surface Wave Platform for Long-Range Directional Couplers and Optical Logic Gates,” *ACS Nano* 16 (2), 2224-2232, 2022.

[2] C. Li *et al.*, “Positive onset potential and stability of Cu₂O-based photocathodes in water splitting by atomic layer deposition of a Ga₂O₃ buffer layer,” *Energy & Environmental Science* 8 (5), 1493-1500, 2015.

Lab. Web page: <http://scale.t.u-tokyo.ac.jp/>