QMODUV

Quantum Modulator for UV Applications

Dr. Wei, David, planqc, david.wei@planqc.eu; Dr. Wolf, Jochen, planqc, jochen.wolf@planqc.eu
Dr. Zeiher, Johannes, planqc, johannes@planqc.eu; Dr. Herr, Simon, Fraunhofer IPM, simon.herr@ipm.fraunhofer.de; Dr. Hugger, Stefan, Fraunhofer IAF, stefan.hugger@iaf.fraunhofer.de;
Dr. Raghuwanshi, Mohit, Fraunhofer IAF, mohit.raghuwanshi@iaf.fraunhofer.de

1 Background

State of the Art

- Existing EO modulators (e.g., $LiNbO_3$) face limitations in UV stability and high losses.
- Al(Sc)N offers a promising alternative with a broad bandgap and improved EO properties under development.

System Being Developed

- Scalable on-chip platform for UV-to-NIR EO modulators in quantum computers.
- Focus: High modulation depth, low optical losses, and stable Qubit control.

Technological Challenges

- Achieving low-loss Al(Sc)N waveguides and reliable EO modulation.
- Ensuring long-term stability under high-intensity laser operation.

2 Innovation

Enabling Technology/Process Development

- Development of Al(Sc)N waveguide fabrication processes to ensure low-loss operation in UV (302–316 nm) and visible ranges.
- Precise lithographic techniques for scalable production of waveguides and EO modulators, ensuring reliable single-mode operation.
- Advanced electrode integration on chips to achieve efficient EO modulation

Project goal

- Measurement of the specifications of Al(Sc)N to see how close to the desirable long-term specifications they come

Long-term specifications after project end

- Optical losses: < 5 dB end-to-end per modulation channel.
- Modulation depth: Driving voltage Vπ < 8 V.
- Modulation speed: Bandwidth > 100 MHz.
- Long-term stability: No significant drifts in optical properties over months
- Optical power: > 5 mW per modulation channel.
- Extinction ratio: Target value of 10^5 for precise and reliable switching operations.

3 Future performance profile & skills of the project partners

Fraunhofer IAF

- Development of scalable Al(Sc)N waveguides and EO modulators for UV-to-NIR applications.
- Target applications:high-power UV lasers, quantum photonics, and neuromorphic computing.

Fraunhofer IPM

- Nonlinear optical waveguides and EO modulators for UV photonics with high efficiency.
- Use in precision optical systems, frequency converters, and advanced photonic integration.

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- Precise Qubit control in neutral atom quantum computers through scalable UV EO modulators.
- Broader applications in quantum information processing and photonic quantum circuits.

4 Prospects

Post-project goals

- Advance the technology from TRL 3 to TRL 5+ through further prototyping, industrial collaborations, and new research partnerships.

Additional applications

- UV-stable EO modulators for optical communication, precision metrology, and high-power UV laser systems.

Broader potential

- Enabling scalable photonic platforms for hybrid quantum systems, and future quantum networking technologies.

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