ABXSens

UV Laser Technology for Raman Spectroscopic Measurement of Antibiotic Levels

Individually tailored antibiotic dosing is a key challenge in treating severe infections. Particularly in intensive care patients, the way the body processes these drugs can change considerably. The ABXSens collaborative research project therefore aimed to establish a technological foundation for rapid monitoring of antibiotic levels using Raman spectroscopy. Sacher Lasertechnik developed a UV laser system operating at a wavelength of approximately 240 nanometres, which was successfully used for spectroscopic investigations.

Project at a glance

- **Collaborative project:** Raman Spectroscopic Measurement of Antibiotic Levels for the Management of Nosocomial Sepsis
- **Acronym:** ABXSens
- **Project duration:** 1 January 2021 to 31 December 2024
- **Sacher Lasertechnik subproject:** UV Laser Based on Two Successive Frequency-Doubling Stages for Resonance Raman Spectroscopy
- **Funding reference:** 13GW0425C
- **Project partners:** Cetoni, Grintech, Leibniz Institute of Photonic Technology (IPHT; work subsequently continued at TU Darmstadt), Sacher Lasertechnik and Sensor Photonics

Objectives and Approach

ABXSens focused on developing a measurement method intended to enable close monitoring and individual adjustment of antibiotic treatment in the future. Raman spectroscopy uses the interaction between laser light and molecules to obtain information about their chemical composition. Excitation in the deep ultraviolet spectral range offers an approach to sensitive and chemically selective analysis.

A suitable laser source is essential for this method. It must deliver sufficient optical power while providing narrow linewidth, low noise and stable operation. Within the consortium, Sacher Lasertechnik developed this key component and investigated ways to miniaturise the laser assemblies.

Sacher Lasertechnik's Contribution

Since direct semiconductor lasers were unavailable at the target wavelength of 240 nanometres, a multistage system was implemented. A narrow-linewidth diode laser initially generates light at 960 nanometres. A subsequent semiconductor amplifier increases the optical power to several watts. Two successive frequency-doubling stages then convert the wavelength first to 480 and finally to 240 nanometres.

To ensure stable operation, Sacher Lasertechnik developed a fast digital control system based on a field-programmable gate array (FPGA). It stabilises both frequency-doubling stages and enables automatic relocking after disturbances. In parallel, a miniaturised master oscillator power amplifier module was developed in a compact butterfly package, achieving output powers exceeding one watt under laboratory conditions.

Results and Outlook

The UV laser system achieved stable output powers of up to 100 milliwatts at 240 nanometres. Project partner TU Darmstadt successfully tested the system for UV Raman spectroscopy, demonstrating the suitability of the developed laser source for the project's spectroscopic research.

ABXSens established a technical foundation for the further development of laser-based methods for monitoring antibiotic levels. Clinical application remains a longer-term objective. Further development opportunities include additional miniaturisation and simplified approaches to generating UV laser light.

Beyond medical diagnostics, the laser assemblies and control technologies developed in the project offer potential for applications in precision spectroscopy, lithography and quantum technology.