CASABLANCA

Compact Blue and UV Laser Sources Based on Metal-Organic Crystals

Compact laser sources in the blue and deep-ultraviolet spectral ranges are important tools for spectroscopy, precision metrology and quantum technologies. Their development requires efficient conversion of available laser wavelengths. The international CASABLANCA collaborative research project is investigating novel metal-organic crystals and their integration into miniaturised laser modules. Sacher Lasertechnik is developing the optical test systems, crystal resonators and coating processes needed to explore these materials' potential for frequency doubling.

Project at a glance

- **Project title:** Frequency-Doubled Laser Diode Modules Based on Metal-Organic Crystals
- **Acronym:** CASABLANCA
- **Project partners:** Sacher Lasertechnik, Technische Universität Berlin and MAQI
- **International collaboration:** Germany and Chile
- **Funding programme:** Central Innovation Programme for SMEs (ZIM)
- **Funding reference:** KK6065102
- **Technology focus:** Nonlinear optical crystals, frequency doubling and micro-optical integration

Objectives and Approach

CASABLANCA is investigating metal-organic frameworks, known as MOFs, for optical frequency conversion. These materials are intended to combine efficient generation of shorter wavelengths with high resistance to environmental influences.

Chilean project partner MAQI is developing and optimising two crystal types. The first is intended to convert infrared laser light at approximately 923 nanometres into blue light at around 461 nanometres. A second, newly developed crystal is intended to enable frequency doubling of blue light into the deep-ultraviolet range around 230 nanometres.

The objective is to produce two compact demonstrator modules to establish the suitability of the materials and integration concept. Investigations will address conversion efficiency, optical power handling and operational stability.

Sacher Lasertechnik's Contribution

Sacher Lasertechnik is developing tunable laser sources and measurement setups to characterise the MOF crystals. Investigations cover absorption, reflection, nonlinear properties and conversion efficiency. Optical cavity setups enable testing at increased optical power densities and identification of suitable operating conditions.

A central development focus is to make the crystal itself act as an optical resonator. To achieve this, the crystal surfaces will be precisely shaped, polished and provided with specialised dielectric coatings. Repeated interaction between the light and the material is intended to enhance frequency conversion even at moderate input powers.

Together with MAQI, Sacher Lasertechnik is investigating suitable anti-reflection and highly reflective coatings. Coating adhesion, material compatibility and optical quality must be carefully matched.

Beam delivery and efficient coupling of pump light into the crystal resonators are also being developed.

For miniaturisation, Sacher Lasertechnik is collaborating with Technische Universität Berlin. The crystals and associated micro-optics are to be mounted on a fused-silica micro-optical bench and integrated into compact modules.

Expected Results and Outlook

By the end of the project, functional demonstrators for generating blue and deep-ultraviolet laser light are expected to be available. System and reliability tests will assess the performance of the new crystals and glass-based packaging under practical operating conditions.

CASABLANCA thus establishes a foundation for a new generation of compact frequency-conversion modules. Potential applications include Raman spectroscopy, material analysis, medical technology and quantum technology. The coating, assembly and packaging processes developed are also intended to support reproducible manufacturing in the future.