UHV-glass cell

Ultra-low birefringence dodecagonal vacuum glass cell for quantum technologies

Invention

The invention consists of a glass cell featuring an ultra-low birefringence (around 10–8) with an outstanding optical access due to its compact dodecagonal shape. The cell is ideally suited for experiments in ultra-high vacuum (UHV) that require the state of polarization to be preserved to the highest degree. Quantum simulations with ultra-cold quantum gases and quantum computing with Rydberg atom arrays require a UHV apparatus with a very large optical access and an accurate preservation of laser beam properties such as the state of polarization and the wave-front quality. For these applications, vacuum glass cells are widely used since they are more compact than metal vacuum chambers and do not require vacuum viewports, which generally suffer from stress-induced birefringence. Furthermore, compact glass cells can be combined with closely positioned electromagnetic coils for the generation of strong magnetic fields and field gradients.

Photograph of the vacuum cell featuring a large-numerical-aperture objective in its interior

The innovative manufacturing process is based on the bonding of double-side antireflection-coated glass windows with epoxy adhesives that fulfill the NASA low outgassing standard. Surface roughness and small deviations from the ideal geometry are compensated by the glue volume, therefore allowing for relatively large tolerances in the glass cutting process. The epoxy bonding technique is also applicable to complex geometries with different shapes, where optical contacting is difficult. In the actual market, a glass cell for UHV experiments featuring ultra-low birefringence is not available. The object of this invention is a process that combines ultra-low birefringence with the excellent optical access of the dodecagonal geometry.

Commercial Opportunities

Ultra-high vacuum cells preserving laser beams' polarization and featuring excellent optical access are crucial for the development of next-generation quantum technologies such as quantum gas simulators, quantum computing with Rydberg atom arrays, and quantum computing with trapped ion arrays. Ultra-low birefringence is also crucial for ultraprecise optical frequency standards and other precision measurement experiments, such as those searching for electric dipole moment and vacuum polarizability.

Current Status

A German patent application has been granted DE 102015013026. On behalf of the University of Bonn PROvendis is seeking a partner for licensing the technology.

Relevant Publications

1) S. Brakhane, W. Alt, D. Meschede, C. Robens, G. Moon, and A. Alberti, "Note: Ultra-low birefringence dodecagonal vacuum glass cell," Rev. Sci. Instrum. 86, 126108 (2015)

An invention of University of Bonn.

Competitive Advantages

- The cell is suitable for applications requiring UHV
- The innovative procedure for application of epoxy glue combined with the use of the special SF-57 glass guarantees ultra-low birefringence (Δn ≈ 10-8)
- Double-side antireflection-coated vacuum glasses ensure negligible transmission losses.
- The manufacturing technique enables the realization of a many-sided glass cell, offering an outstanding optical access.
- The inner volume of the glass cell is sufficiently large to host scientific components (e.g., objective lens, atom chip, optical cavities, ion traps, Faraday shield, etc.)

Technology Readiness Level

1 2 3 4 **5** 6 7 8 9

Technology validated in relevant environment

Industries

- Physical Industry

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