Contribution ID: **351** Type: **Contributed**

# Gas Modulation Refractometry for High-Precision Assessment of Pressure under Non-Temperature-Stabilized Conditions

*Tuesday 19 June 2018 16:20 (20 minutes)*

We report on the realization of a novel methodology for refractometry —GAs MOdulation Refractometry (GAMOR) —that decreases the influence of drifts in Fabry Perot cavity refractometry. The instrumentation is based on a dual Fabry-Perot cavity (DFPC) refractometer in which one cavity is used as the measurement cavity while the other serves as the reference. The GAMOR methodology comprises a repeatedly filling and emptying of the measurement cavity to recurrently assess the beat frequency from an empty cavity. This opens up for the use of refractometry under non-temperature-stabilized conditions. A first version of a GAMOR methodology has been realized and its basic performance has been scrutinized. It is based upon a DFPC refractometer made of Zerodur and tunable narrow linewidth fiber lasers operating around 1.55 μm, at which there are a multitude of off-the-shelves optical, electro-optic, and acousto-optic components (of which many are fiber coupled). The system is fully computer controlled, which implies it can perform unattended gas assessments over any foreseeable length of time. When applied to a system with no active temperature stabilization, the GAMOR methodology has demonstrated a three orders of magnitude improvement of the precision with respect to static detection. When referenced to a dead weight pressure scale the instrumentation has demonstrated assessment of pressures in the kPa range (4303 and 7226 Pa) limited by white noise with standard deviations in the 3.2 - 3.5 mPa(# of measurement cycles)ˆ(1/2) range. This implies that for short measurement times the system exhibits a (1 sigma) total relative precision of 0.7 (0.5) ppm for assessment of pressures in the 4 kPa region and 0.5 (0.4) ppm for pressures around 7 kPa, where the numbers in parentheses represent the part of the total noise that has been attributed to the refractometer. The inherent properties of the GAMOR methodology open up for a variety of applications within metrology. It does not only have the potential to compete favorably with manometers for assessments of gas pressure, it can also be used for transfer of calibration between different pressure regions and characterization of a variety of pressure gauges, including piston gauges. Besides presenting the overall technique, its strength and limitations, we will present the latest upgrades to our system, as well as new improved results.

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**Session Classification:** Vacuum Science & Technology

**Track Classification:** Vacuum Science & Technology