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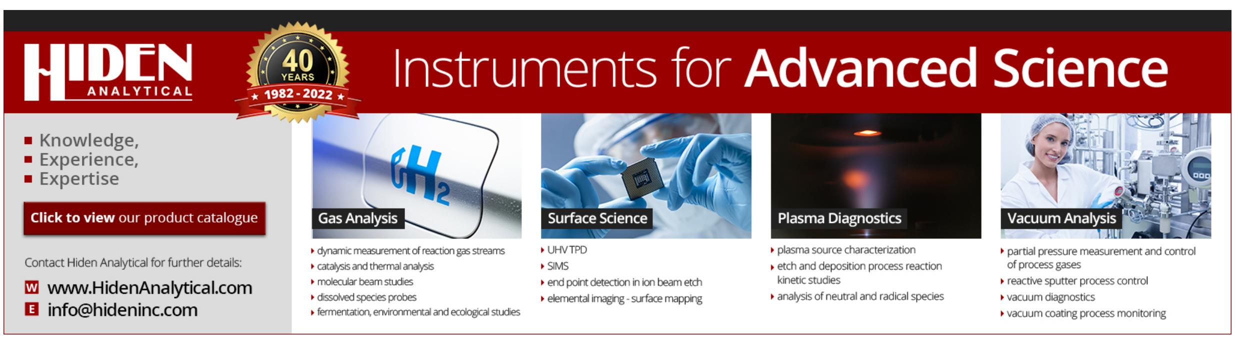

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The authors of the referenced paper[1] have unanimously agreed to retract it since it contains a flaw that invalidates its conclusions.

The paper presents an expression that predicts that Fabry–Pérot (FP) cavity based refractometry can be performed without any influence of mirror penetration depth if the mirror coating comprises a quarter wave stack (QWS) of type H (for which the outermost layer has a higher index of refraction than the subsequent one). However, it has been found that the derivation of the expression that serves as a basis for this statement contains a fallacy. This implies that the conclusions mediated by the paper are incorrect.

The derivation of the expression for the refractivity is based on the difference between the cavity frequencies in the absence and presence of gas, ν_0 and ν_g, respectively.

Appendix A1 in the referenced paper provides, based on a phase condition, a derivation of an expression for the empty mode cavity frequency of an FP cavity comprising high-reflection coated mirrors that (in the absence of Gouy phase and group delay dispersion) reads

$$\nu_0 = \frac{[m_0 - 2\phi_{des}/2\pi + 2T_g^0\nu_{des}]c}{2\left(L_0 + cT_g^0\right)} = \frac{q_0 c}{2\left(L_0 + 2L_{pd}^0\right)}, \qquad (1)$$

where m_0 is the mode number, ϕ_{des} is the phase shift experienced by the light at the surface of the mirrors at the design wavelength, T_g^0 is the group delay of the mirrors for an empty cavity,[2,3] and ν_{des} is the design wavelength. In the last step, we have introduced q_0 as a shorthand notation for $m_0 - 2\phi_{des}/2\pi + 2T_g^0\nu_{des}$ and used L_{pd}^0, representing the frequency penetration depth, to denote $cT_g^0/2$.

It is claimed in the referenced paper that, for the case with a cavity comprising mirrors with QWS reflection coatings of type H, the cavity mode frequency in the presence of gas is given by Eq. (10). However, this expression is unfortunately not fully adequate.

The correct expression can be derived from the corresponding general expression for the cavity frequency from a cavity comprising gas, which reads

$$\nu_g = \frac{[m_0 + \Delta m - 2\phi_{des}/2\pi + 2T_g(n)\nu_{des}]c}{2\left[nL_0 + n\delta L + cT_g(n)\right]}, \qquad (2)$$

where Δm is the number of mode jumps the laser makes, $T_g(n)$ is the group delay of the mirrors in the presence of gas with an index of refraction of n, and δL represents the physical deformation of the cavity due to the presence of the gas.

As has been recently shown by Koks and van Exter,[4] for the case with a cavity comprising mirrors with QWS reflection coatings of type H, $T_g(n)$ is given by nT_g^0. This implies that Eq. (2) can be written as

$$\nu_g = \frac{[m_0 + \Delta m - 2\phi_{des}/2\pi + n\gamma]c}{2n\left(L_0 + \delta L + cT_g^0\right)} = \frac{[q_0 + \Delta q + (n-1)\gamma]c}{2n\left(L_0 + \delta L + 2L_{pd}^0\right)}, \qquad (3)$$

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where we, for simplicity, have introduced γ as a shorthand notation for $2T_g^0\nu_{des}$ since it represents a fully material-based parameter of the mirrors, for mirrors with QWS reflection, the coating of type H is given by $(n_H - n_L)^{-1}$, where n_H and n_L are the indices of refraction of the two materials making up the QWS, respectively. For simplicity, here, we have also made use of the definition of q_0 from above and denoted Δm by Δq.

A comparison with Eq. (10) in the referenced paper[1] shows that the two expressions differ by the $(n-1)\gamma$ term; since this term is typically nine orders of magnitude smaller than the leading term within the brackets in the nominator,[5] it was inadvertently left out in Eq. (10) in the referenced paper.

This implies that Eq. (A11) in the referenced paper, which is the basis for the derivation of the expression for the refractivity of the gas assessed by a cavity comprising mirrors with QWS reflection coatings of type H, which, in turn, is given by Eqs. (A16) and (11), is incorrect.[6] A re-derivation of the expression for the refractivity, based on the correct expression for ν_g, given by Eq. (3) above, shows that it, for all practical purposes, agrees with Eq. (4) in the referenced paper, which, in turn, agrees with the expressions used by Egan and Stone[7] and Zakrisson *et al.*[8] previously given in the literature.[9]

This implies that the main conclusions mediated by the paper are incorrect; FP cavity based refractometry *cannot* be performed without any influence of mirror penetration depth by using mirror coatings comprising a QWS of type H.

Since the referenced paper was published only a few months ago (December 1, 2021), it has so far, to the authors knowledge, neither been used as a basis for any scientific work nor been cited by any other publication. We, therefore, believe that it has had a minimal impetus on the scientific community.

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[2] R. Paschotta, see https://www.rp-photonics.com/group˙delay.html for article on "group delay" in the RP photonics encyclopedia; accessed 22 September 2021.
[3] Denoted T_g in the referenced paper, but here, for clarity, denoted T_g^0.
[4] C. Koks and M. P. van Exter, Opt. Express **29**, 6879 (2021).
[5] For the case with nitrogen under atmospheric pressure, for which $n-1$ is ca. 3×10^{-4}, with $n_H - n_L$ being in the order of unity, and q_0 typically taking a value of 2×10^5, $(n-1)\gamma$ is ca. 1.5×10^{-9} times smaller than q_0.
[6] Incorrect Eqs. (A16) and (11) provide an adequate expression for the refractivity assessed by FP-based refractometry in the absence of penetration depth.
[7] P. F. Egan and J. A. Stone, Appl. Opt. **50**, 3076 (2011).
[8] J. Zakrisson, I. Silander, C. Forssén, M. Zelan, and O. Axner, J. Vac. Sci. Technol. B **38**, 054202 (2020).
[9] Equations (A16) and (11) differ from Eq. (4) by an amount given by the relative penetration depth, $2\overline{L_{pd}^0}$, which is given by $(c\gamma)/(2L_0\nu_{des})$. For the case with γ, L_0, and ν_{des} being 1, 0.15 m and 2×10^{14} Hz, respectively, $2\overline{L_{pd}^0}$ takes a value of 5×10^{-6}.

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