用于原位监测纳米薄膜特性的全光纤椭偏仪

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传统的椭偏法无法直接测量纳米薄膜的厚度和折射率，需要预先建立复杂的薄膜材料光学模型才能实现精准测量，因此，亟需开发一种新型纳米薄膜特性测试方法。

西班牙纳瓦拉公立大学 Ignacio R. Matías 教授的传感器研究小组与加拿大卡尔顿大学 Jacques Albert 教授领导的的先进光子元件实验室提出了一种可用于原位监测纳米薄膜沉积过程中对应性能的全光纤椭偏仪。实验采用原子层沉积 (ALD) 技术在光纤上沉积了二氧化钛 (TiO_2) 薄膜，并通过比较沉积过程中的 8 个倾斜布拉格光纤光栅 (TFBG) 包层模式共振的多波长位移与从厚度范围 (T) 和折射率实部值 (n) 的模拟位移，测量了薄膜的厚度和折射率。此外通过获取每个 (n，T) 模拟的最小总误差，还能够得到最佳折射率所对应的薄膜厚度，即折射率为 2.25 时所对应的 TiO_2 厚度为 185 nm，TFBG 的最终值均在常规椭偏仪和扫描电子显微镜验证测量值的 4% 以内。

该研究结果可实现用于监测 TFBG 波长范围内的纳米薄膜材料及折射率高于光纤的纳米薄膜的沉积过程。通过进一步的研发突破，或将能够实现更低折射率和更宽波长范围纳米薄膜材料沉积过程的原位监测。

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All-fiber ellipsometer for nanoscale dielectric coatings

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The most established method to simultaneously determine the refractive index and the thickness of thin films, with a wide range of available commercial solutions, is ellipsometry. However, this technique does not directly measure the thickness and the refractive index, but calculates them based on optical measurements and an optical model of the thin film material that must be known in advance.

The Sensors research group of Prof. Ignacio R. Matías from the Public University of Navarra (Spain), in collaboration with the Advanced Photonic Components Laboratory of Prof. Jacques Albert from Carleton University (Canada), propose a completely different approach to determine the thickness and refractive index of thin films, based on the wavelength shifts of multiple cladding mode resonances in tilted fiber Bragg gratings (TFBGs). This approach provides a method to measure the formation of nanoscale dielectric coatings on fibers in situ for applications that require precise thicknesses and refractive indices, such as the optical fiber sensor field. Furthermore, the TFBG can also be used as a process monitor for deposition on other substrates with deposition methods that produce uniform coatings on dissimilar shaped substrates.

The developed technique contrasts with other conventional methods to determine the properties of such thin films that rely on co-located witness samples, such as ellipsometry, or on destructive measurements using some of the coated fibers.

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