Frequency-comb-assisted terahertz continuous-wave spectroscopy for non-destructive testing

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The terahertz range, spanning from 0.1 to 10 THz on the electromagnetic spectrum, lies between radio and optical frequencies. It holds promise for applications in various industries, including next-generation wireless communication and non-destructive testing. Terahertz spectroscopy has found utility in identifying flaws in non-conductive materials and measuring the thickness of multi-layer dielectric coatings by analyzing the spectrum. To ensure the reliability of non-destructive testing, precise spectrum measurement is essential. In this study, we introduce an advanced terahertz continuous-wave spectroscopy that employs an optical frequency comb, enhancing the reliability of non-destructive testing significantly. This method involves the use of two infrared lasers in a photomixer to generate terahertz continuous waves corresponding to their frequency difference. We achieve wide-ranging frequency control by sweeping one of the lasers' frequencies. To achieve high precision in specifying terahertz frequencies, we employ a frequency comb that is stabilized to a time and frequency standard. This precise spectrum definition enables us to measure the physical properties and geometry of the tested object with exceptional accuracy. Through the integration of the precision offered by optical frequency combs and terahertz continuous wave spectroscopy technology, our study showcases the capacity for achieving ultra-precise non-destructive testing. This advancement has practical applications in the semiconductor and battery industries, where it is anticipated to result in enhanced product quality.