Terahertz-field guidance and resonance in artificial dielectric to approach molecular sensing

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Abstract:
The terahertz electromagnetic field is essential for spectroscopic analysis in biochemistry because the corresponding photon energy and pulse duration easily perturb inter-molecular binding to generate collective motion. Compared with the distinct absorption lines of intro-molecular vibrations in the infrared spectrum, inter-molecular dynamics expressed in terahertz spectroscopy cannot sense minute amounts of analytes or exhibits distortion for slight power variations in recognition. Artificial dielectric materials exploited as terahertz-wave sensors display highly-sensitive detection abilities and are suitable for various conformations of analytes. These materials include functional waveguides, meta-materials, photonic crystals, and dielectric porous media. Evanescent fields in functional waveguides is expressed for sensing applications, and its integration with a periodical metal structure shows that the terahertz far field can be confined for sensing particles at air–metal interfaces. A two-dimensional periodic structure of metal rod array is prepared for a meta-material to mimic plasma frequency in the terahertz region. The structure is also considered as a photonic crystal that possesses predictable photonic band gaps. A strong interference field is observed in the metal-rod space, which is sensitive to the loaded analytes because of the enhanced interaction length. Dielectric porous media are also presented for gaseous and interfacial-water sensing applications based on the property of large interface area.