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ATR FT-IR Absorption Enhancement of a Thin Film under the Photon-Tunneling Condition

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A simple, yet very powerful technique for the spectral acquisition of an extremely thin film with enhanced absorption was explored. An infrared absorption of an extremely thin film confined between media of high refractive indices was greater than that of its bulk when the spectrum was acquired under the attenuated total reflection (ATR) condition with parallel (p) polarized radiation. The absorption enhancement was not observed under perpendicular (s) polarized radiation. Theoretical investigations indicated that the absorption enhancement was proportional to the integration of the mean square evanescent field within the film. The field integration under p-polarized radiation increased, while that under spolarized radiation decreased as the thickness of the confined film became thinner. The maximum enhancement was observed when the film was sufficiently thinner than the penetration depth. The phenomena were experimentally investigated, and the results agreed very well with theoretical predictions.