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# Surface Enhanced Infrared Absorption for Detection of Ultra Trace of 3,4-Methylene Dioxy- Methamphetamine (MDMA)

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**Abstract :** Optical properties of molecules exhibit dramatic changes when adsorbed close to nano-structure metallic surfaces such as gold and silver nanomaterial. This phenomena opened a wide range of research to improve conventional spectroscopies efficiency. A well-known technique that has an intensive focus of study is surface-enhanced Raman spectroscopy (SERS), as since the first observation of SERS phenomena, researchers have published a great number of articles about the potential mechanisms behind this effect as well as developing materials to maximize the enhancement. Infrared and Raman spectroscopy are complementary techniques; thus, surface-enhanced infrared absorption (SEIRA) also shows a noticeable enhancement of molecules in the mid-IR excitation on nonmetallic structure substrates. In the SEIRA, vibrational modes that gave change in dipole moments perpendicular to the nano-metallic substrate enhanced 200 times greater than the free molecule's modes. SEIRA spectroscopy is promising for the characterization and identification of adsorbed molecules on metallic surfaces, especially at trace levels. IR reflection-absorption spectroscopy (IRAS) is a well-known technique for measuring IR spectra of adsorbed molecules on metallic surfaces. However, SEIRA spectroscopy sensitivity is up to 50 times higher than IRAS. SEIRA enhancement has been observed for a wide range of molecules adsorbed on metallic substrates such as Au, Ag, Pd, Pt, Al, and Ni, but Au and Ag substrates exhibited the highest enhancement among the other mentioned substrates. In this work, trace levels of 3,4-methylenedioxymethamphetamine (MDMA) have been detected using gold nanoparticles (AuNPs) substrates with surface-enhanced infrared absorption (SEIRA). AuNPs were first prepared and washed, then mixed with different concentrations of MDMA samples. The process of fabricating the substrate prior SEIRA measurements included mixing of AuNPs and MDMA samples followed by vigorous stirring. The stirring step is particularly crucial, as stirring allows molecules to be robustly adsorbed on AuNPs. Thus, remarkable SEIRA was observed for MDMA samples even at trace levels, showing the rigidity of our approach to preparing SEIRA substrates.

**Keywords :** surface-enhanced infrared absorption (SEIRA), gold nanoparticles (AuNPs), amphetamines, methylene dioxy-methamphetamine (MDMA), enhancement factor
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