

# CHEMICAL SENSOR USING SINGLE CRYSTAL DIAMOND PLATES INTERROGATED WITH CHARGE-BASED DEEP-LEVEL TRANSIENT SPECTROSCOPY BASED ON THE QUANTUM FINGERPRINT™ MODEL: INSTRUMENTATION AND METHODOLOGY

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## ABSTRACT

In recent years, diamond has received a great deal of interest as a potential chemical sensor material due to its mechanical robustness, and its capacity to modify its electrical characteristics according to surface termination and adsorbed chemical agents. Previous studies have suggested that an adsorbed molecule can localize a carrier in the same way a surface trap can. The present work focuses on molecules chemisorbed to the oxygen-terminated surfaces of high-purity CVD single crystal (100) diamond plates. Potentially, a given adsorbed molecule can be uniquely related to a new surface energy state, thus producing a characteristic spectral signature. This technology is named Quantum Fingerprinting™. To investigate the adsorbate-induced surface energy states, an ultra-sensitive, non-steady state interrogation device called Charge-based Deep-Level Transient Spectrometer (Q-DLTS) was built and tested. This system was used to investigate the effects of various basic alcohols and benzene derivatives on the surface states of the sensor. It was found that both types of molecules produce a large primary spectral peak and a smaller, transient one. For alcohol, both peaks display a consistent increase in amplitude as the molecule's carbon content becomes larger. The secondary peak shows a faster emission rate with heavier alcohol molecules. This was attributed to the appearance of new surface states. The secondary peak of the benzene derivative disappears a few minutes after the initial introduction. This is believed to be the result of physisorption.