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Low-energy electron scattering from α-tetrahydrofurfuryl alcohol

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Synopsis We report on differential cross section results for low-energy electron collisions with the biologically relevant species α-tetrahydrofurfuryl alcohol. Electron-impact excitation measurements of the electronic states of α-tetrahydrofurfuryl alcohol were carried out at incident energies between 15-50 eV and for scattering angles in the range 20-90°. Elastic differential cross section have also been calculated within the Independent Atom Model and using the Screening Corrected Additivity Rule approach at selected energies between 1-1000 eV.

Investigations of low-energy electron interactions with the sub-units of the nucleic acids, or their analogues, have in recent years become a topical field of study in atomic and molecular physics in order to understand how charged particles can induce damage in biomolecular systems [1]. The knowledge of the collision cross sections, which define the probability of specific scattering events, is particularly useful in simulating how energy is deposited in the biological medium, and can thus be used to characterise the extent of any radiation-induced damage.

α-tetrahydrofurfuryl alcohol (THFA, $C_5H_{10}O_2$) is a close chemical analog of the sugar rings present in the phosphate-deoxyribose backbone structure of the nucleic acids [2]. As such, THFA can be considered as a suitable analogue for investigating how low-energy electrons interact with the larger macro-molecules found in biological systems.

Here we report on differential cross section (DCS) measurements for the low-energy electron-impact excitation of the electronic states of THFA. For this purpose, electron energy loss spectra (EELS) have been measured at selected incident energies between 15 eV and 50 eV and for scattering angles in the 20-90° range. These experiments were carried out on an electron spectrometer located at Flinders University, with the details of its construction and operation being presented elsewhere [3].

EELSs at each incident electron energy and scattering angle are then converted into DCSs by comparing the relative intensity observed between the inelastic and elastic scattering features. Here the absolute scale of the inelastic cross sections is set by the absolute scale of the elastic DCSs. These were obtained from calculations performed within the Independent Atom Model with the Screening Corrected Additivity Rule formalism (see e.g. [4]) at energies spanning 1-1000 eV.

The present low-energy experimental results are compared against the existing intermediate-energy electron-impact excitation results [5]. In order to understand the importance of chemical substitutions in low-energy electron interactions, we also compare the present inelastic DCSs for THFA to our previous low-energy electron-impact excitation results for the structurally related species tetrahydrofuran [6].

The present work significantly contributes to our understanding of low-energy electron interactions with biomolecules. This understanding is essential for developing accurate models and interpreting results of radiation-induced damage in biological systems.

References

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