Electronic Collisions with Molecules of Biological Relevance

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Abstract

Experimental studies of radiation damage in living tissue indicate that it is not just the primary ionizing particle responsible for the bulk of the radiation damage, but also secondary species generated by the ionizing particle. There is much interest in how these secondary particles, commonly electrons, interact with bio-molecules and in particular DNA.

In this thesis, I report relative triple differential cross section measurements for the electron impact ionization of formic acid, tetrahydrofuran and thymine. Formic acid can be considered one of the simplest building blocks for biological systems, particularly in the formation of glycine and amino acids. Tetrahydrofuran is a simple ring structure that can be used as a good approximation to the sugar component of the deoxyribose backbone. Thymine, together with cytosine, guanine and adenine, are the DNA bases and their interactions with electrons are considered to be of great importance. Single differential cross sections for elastic electron interactions with cytosine and thymine are also reported.

Declaration

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution to Christopher J. Colyer and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where reference has been made in the text.

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March 4th 2011

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List of Abbreviations

1CW	One Centre Coulomb Wave
ADC	Analogue-to-Digital Convertor
BBK	Branner, Briggs and Klar
BNC	Bayonet Neill-Concelman
CEM	Channel Electron Multiplier
CF	Conflat
CFD	Constant Fraction Discriminator
CPE	Correlation, Polarization and Exchange
DAQ	Data Acquisition
DDCS	Double Differential Cross Section
DEA	Dissociative Electron Attachment
DNA	Deoxyribose Nucleic Acid
DS3C	Dynamic Screening of Three Two-Body Coulomb Interactions
DSB	Double Strand Breaks
DWBA	Distorted-Wave Born Approximation
EMS	Electron Momentum Spectroscopy
FBA	First Born Approximation
FBA-TCC	First Born Approximation-Two Centre Continuum
FWHM	Full Width at Half Maximum
HOMO	Highest Occupied Molecular Orbital
IAM	Independent Atom Method
ICS	Integral Cross Section
LUMO	Lowest Unoccupied Molecular Orbital
M3DW	Molecular Three-Body Distorted-Wave

MAC	Magnetic Angle Changer
MCP	Microchannel Plate
MTCS	Momentum Transfer Cross Section
NI	National Instruments
NIM	Nuclear Instrumentation Module
OAMO	Orientation Averaged Molecular Orbital
OFHC	Oxygen-Free High Conductivity
PCI	Post Collision Interaction
PSD	Position Sensitive Detector
PTFE	Polytetrafluoroethylene
PWIA	Plane Wave Impulse Approximation
RNA	Ribose Nucleic Acid
SBR	Signal-to-Background Ratio
SCAR	Screening Corrected Additivity Rule
SDCS	Single Differential Cross Section
SS	Stainless Steel
SSB	Single Strand Breaks
TAC	Time-to-Amplitude Convertor
TC	Thermocouple
TDCS	Triple Differential Cross Section
THF	Tetrahydrofuran
TTL	Transistor-Transistor Logic

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