# Copolymers of Acrylamide Derivatives
## Synthesis, Characterization and Structure-Property Correlation

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This dissertation is submitted for the degree of
*Doctor of Philosophy*

May 2025

I would like to dedicate this thesis to my loving parents . . .

# Declaration

I hereby declare that except where specific reference is made to the work of others, the contents of this dissertation are original and have not been submitted in whole or in part for consideration for any other degree or qualification in this, or any other university. This dissertation is my own work and contains nothing which is the outcome of work done in collaboration with others, except as specified in the text and Acknowledgements. This dissertation contains fewer than 65,000 words including appendices, bibliography, footnotes, tables and equations and has fewer than 150 figures.

Rop Aron K.
May 2025

# Acknowledgements

And I would like to acknowledge ...

# Abstract

This is where you write your abstract ...

# Table of contents

# List of figures

# List of tables

# Nomenclature

**Roman Symbols**

$F$      complex function

**Greek Symbols**

$\alpha$      Specific rotation

$\gamma$      a simply closed curve on a complex plane

$\iota$      unit imaginary number $\sqrt{-1}$

$\mu$      Deviation

$\pi$      $\simeq 3.14\ldots$

**Superscripts**

$j$      superscript index

**Subscripts**

0      subscript index

crit      Critical state

**Other Symbols**

$\oint_{\gamma}$      integration around a curve $\gamma$

**Acronyms / Abbreviations**

ALU      Arithmetic Logic Unit

BEM      Boundary Element Method

CD      Contact Dynamics

CFD     Computational Fluid Dynamics

*CIF*   Cauchy's Integral Formula

CK      Carman - Kozeny

DEM     Discrete Element Method

DKT     Draft Kiss Tumble

DNS     Direct Numerical Simulation

EFG     Element-Free Galerkin

FEM     Finite Element Method

FLOP    Floating Point Operations

FPU     Floating Point Unit

FVM     Finite Volume Method

GPU     Graphics Processing Unit

LBM     Lattice Boltzmann Method

LES     Large Eddy Simulation

MPM     Material Point Method

MRT     Multi-Relaxation Time

NAM     N-acryloylmorpholine

NIPA    N-isopropylacrylamide

PCI     Peripheral Component Interconnect

PFEM    Particle Finite Element Method

PIC     Particle-in-cell

PPC     Particles per cell

RVE     Representative Elemental Volume

SH    Savage Hutter

SM    Streaming Multiprocessors

USF    Update Stress First

USL    Update Stress Last

# Chapter 1

# Getting started

## 1.1 What is loren ipsum? Title with math $\sigma$

Lorem Ipsum is simply dummy text of the printing and typesetting industry (see Section 1.3). Lorem Ipsum [1] has been the industry's standard dummy text ever since the 1500s, when an unknown printer took a galley of type and scrambled it to make a type specimen book. It has survived not only five centuries, but also the leap into electronic typesetting, remaining essentially unchanged. It was popularised in the 1960s with the release of Letraset sheets containing Lorem Ipsum passages, and more recently with desktop publishing software like Aldus PageMaker including versions of Lorem Ipsum [2–4]

The most famous equation in the world: $E^2 = (m_0 c^2)^2 + (pc)^2$, which is known as the **energy-mass-momentum** relation as an in-line equation.

A *LaTeX class file* is a file, which holds style information for a particular LaTeX.

$$CIF: \quad F_0^j(a) = \frac{1}{2\pi\iota} \oint_\gamma \frac{F_0^j(z)}{z-a} dz \tag{1.1}$$

## 1.2 Chemistry training

This section will test some common chemistry typeface. For example $N-$isopropylacrylamide and $H_2O$ and the relaxation in proton $^1$H NMR and relaxation of Gd(III) complexes. Even it is important to check how paragraphs are rendered. How degrees symbol is printed out $17°$C. The next is finding out about nomenclature. e.g. NIPA (N-isopropylacrylamide) is a common thermoresponsive monomer

This is a new paragraph and hopefully it turns out well. How citations are rendered is also important [2] as well as in-text [5][1] and [2]

It is a long established fact that a reader will be distracted by the readable content of a page when looking at its layout. The point of using Lorem Ipsum is that it has a more-or-less normal distribution of letters, as opposed to using 'Content here, content here', making it look like readable English. Many desktop publishing packages and web page editors now use Lorem Ipsum as their default model text, and a search for 'lorem ipsum' will uncover many web sites still in their infancy. Various versions have evolved over the years, sometimes by accident, sometimes on purpose (injected humour and the like).

## 1.3   Where does it come from?

Contrary to popular belief, Lorem Ipsum is not simply random text. It has roots in a piece of classical Latin literature from 45 BC, making it over 2000 years old. Richard McClintock, a Latin professor at Hampden-Sydney College in Virginia, looked up one of the more obscure Latin words, consectetur, from a Lorem Ipsum passage, and going through the cites of the word in classical literature, discovered the undoubtable source. Lorem Ipsum comes from sections 1.10.32 and 1.10.33 of "de Finibus Bonorum et Malorum" (The Extremes of Good and Evil) by Cicero, written in 45 BC. This book is a treatise on the theory of ethics, very popular during the Renaissance. The first line of Lorem Ipsum, "Lorem ipsum dolor sit amet..", comes from a line in section 1.10.32.

The standard chunk of Lorem Ipsum used since the 1500s is reproduced below for those interested. Sections 1.10.32 and 1.10.33 from "de Finibus Bonorum et Malorum" by Cicero are also reproduced in their exact original form, accompanied by English versions from the 1914 translation by H. Rackham

"Lorem ipsum dolor sit amet, consectetur adipisicing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum."

Section 1.10.32 of "de Finibus Bonorum et Malorum", written by Cicero in 45 BC: "Sed ut perspiciatis unde omnis iste natus error sit voluptatem accusantium doloremque laudantium, totam rem aperiam, eaque ipsa quae ab illo inventore veritatis et quasi architecto beatae vitae dicta sunt explicabo. Nemo enim ipsam voluptatem quia voluptas sit aspernatur aut odit aut fugit, sed quia consequuntur magni dolores eos qui ratione voluptatem sequi nesciunt. Neque porro quisquam est, qui dolorem ipsum quia dolor sit amet, consectetur, adipisci velit, sed

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1914 translation by H. Rackham: "But I must explain to you how all this mistaken idea of denouncing pleasure and praising pain was born and I will give you a complete account of the system, and expound the actual teachings of the great explorer of the truth, the master-builder of human happiness. No one rejects, dislikes, or avoids pleasure itself, because it is pleasure, but because those who do not know how to pursue pleasure rationally encounter consequences that are extremely painful. Nor again is there anyone who loves or pursues or desires to obtain pain of itself, because it is pain, but because occasionally circumstances occur in which toil and pain can procure him some great pleasure. To take a trivial example, which of us ever undertakes laborious physical exercise, except to obtain some advantage from it? But who has any right to find fault with a man who chooses to enjoy a pleasure that has no annoying consequences, or one who avoids a pain that produces no resultant pleasure?"

Section 1.10.33 of "de Finibus Bonorum et Malorum", written by Cicero in 45 BC: "At vero eos et accusamus et iusto odio dignissimos ducimus qui blanditiis praesentium voluptatum deleniti atque corrupti quos dolores et quas molestias excepturi sint occaecati cupiditate non provident, similique sunt in culpa qui officia deserunt mollitia animi, id est laborum et dolorum fuga. Et harum quidem rerum facilis est et expedita distinctio. Nam libero tempore, cum soluta nobis est eligendi optio cumque nihil impedit quo minus id quod maxime placeat facere possimus, omnis voluptas assumenda est, omnis dolor repellendus. Temporibus autem quibusdam et aut officiis debitis aut rerum necessitatibus saepe eveniet ut et voluptates repudiandae sint et molestiae non recusandae. Itaque earum rerum hic tenetur a sapiente delectus, ut aut reiciendis voluptatibus maiores alias consequatur aut perferendis doloribus asperiores repellat."

1914 translation by H. Rackham: "On the other hand, we denounce with righteous indignation and dislike men who are so beguiled and demoralized by the charms of pleasure of the moment, so blinded by desire, that they cannot foresee the pain and trouble that are bound to ensue; and equal blame belongs to those who fail in their duty through weakness of will, which is the same as saying through shrinking from toil and pain. These cases are perfectly simple and easy to distinguish. In a free hour, when our power of choice is untrammelled and when nothing prevents our being able to do what we like best, every pleasure is to be welcomed and every pain avoided. But in certain circumstances and owing to the claims of duty or the obligations of business it will frequently occur that pleasures have to be repudiated and annoyances accepted.

The wise man therefore always holds in these matters to this principle of selection: he rejects pleasures to secure other greater pleasures, or else he endures pains to avoid worse pains."

# Chapter 2

# My second chapter

## 2.1 Reasonably long section title

The SI Units for dynamic viscosity is $\mathrm{N\,s\,m^{-2}}$. I'm going to randomly include a picture Figure 2.1.

If you have trouble viewing this document contact Krishna at: kks32@cam.ac.uk or raise an issue at https://github.com/kks32/phd-thesis-template/

## Enumeration

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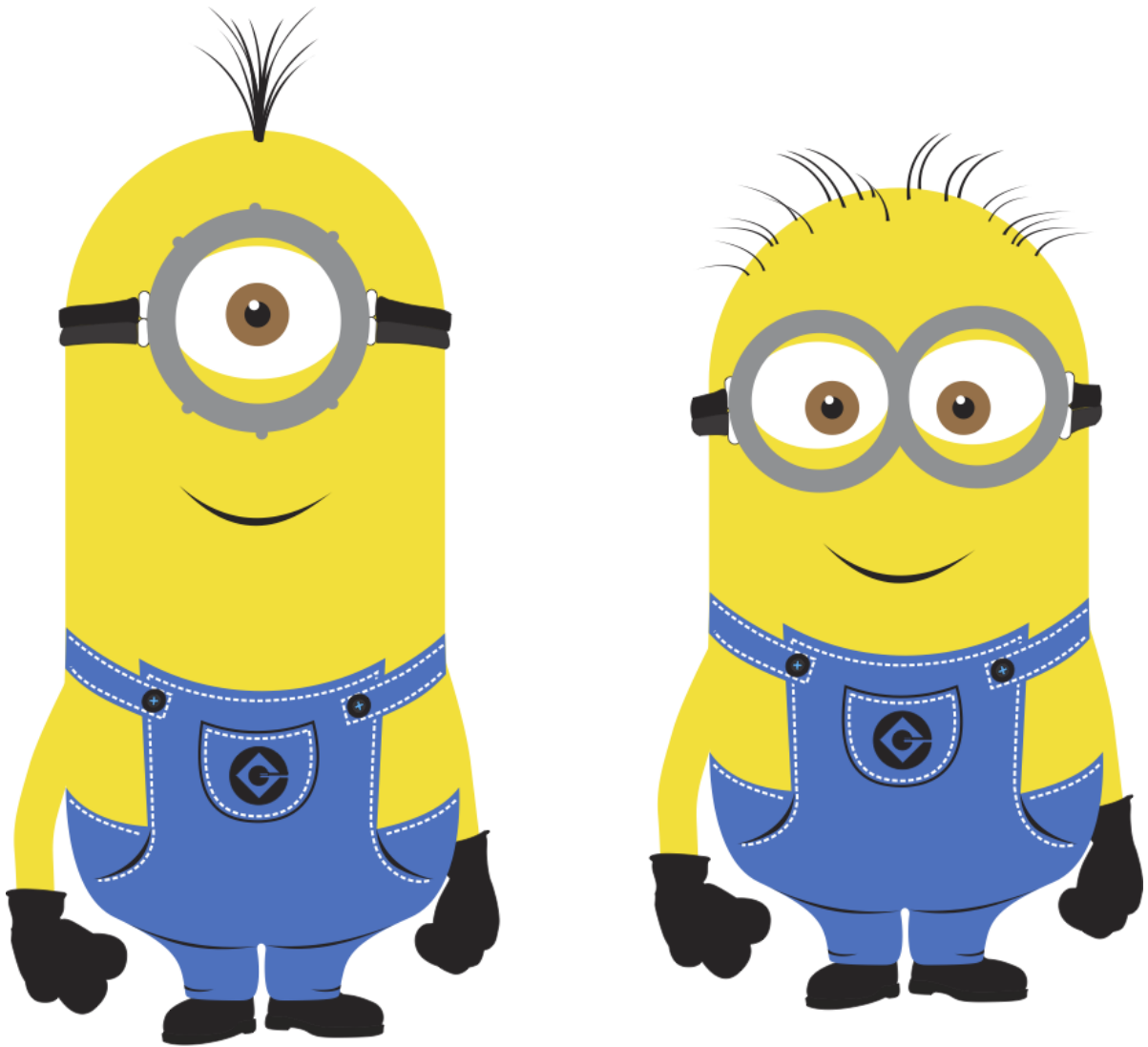
Fig. 2.1 This is just a long figure caption for the minion in Despicable Me from Pixar

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1. The first topic is dull

2. The second topic is duller

    (a) The first subtopic is silly

    (b) The second subtopic is stupid

3. The third topic is the dullest

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## Itemize

- The first topic is dull

- The second topic is duller

    – The first subtopic is silly

    – The second subtopic is stupid

- The third topic is the dullest

## Description

**The first topic**  is dull

**The second topic**  is duller

   **The first subtopic**  is silly

   **The second subtopic**  is stupid

**The third topic**  is the dullest

## 2.2   Hidden section

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[1]My footnote goes blah blah blah! . . .

## Subplots

I can cite Wall-E (see Fig. 2.2b) and Minions in despicable me (Fig. 2.2c) or I can cite the whole figure as Fig. 2.2



(a) Tom and Jerry  (b) Wall-E  (c) Minions

Fig. 2.2 Best Animations

# Chapter 3

# My third chapter

## 3.1 First section of the third chapter

And now I begin my third chapter here . . .

And now to cite some more people [6, 5]

### 3.1.1 First subsection in the first section

. . . and some more

### 3.1.2 Second subsection in the first section

. . . and some more . . .

**First subsub section in the second subsection**

. . . and some more in the first subsub section otherwise it all looks the same doesn't it? well we can add some text to it . . .

### 3.1.3 Third subsection in the first section

. . . and some more . . .

**First subsub section in the third subsection**

. . . and some more in the first subsub section otherwise it all looks the same doesn't it? well we can add some text to it and some more and some more and some more and some more and some more and some more and some more . . .

**Second subsub section in the third subsection**

. . . and some more in the first subsub section otherwise it all looks the same doesn't it? well we can add some text to it . . .

## 3.2  Second section of the third chapter

and here I write more . . .

## 3.3  The layout of formal tables

This section has been modified from "Publication quality tables in LATEX*" by Simon Fear.

The layout of a table has been established over centuries of experience and should only be altered in extraordinary circumstances.

When formatting a table, remember two simple guidelines at all times:

1.  Never, ever use vertical rules (lines).

2.  Never use double rules.

These guidelines may seem extreme but I have never found a good argument in favour of breaking them. For example, if you feel that the information in the left half of a table is so different from that on the right that it needs to be separated by a vertical line, then you should use two tables instead. Not everyone follows the second guideline:

There are three further guidelines worth mentioning here as they are generally not known outside the circle of professional typesetters and subeditors:

3.  Put the units in the column heading (not in the body of the table).

4.  Always precede a decimal point by a digit; thus 0.1 *not* just .1.

5.  Do not use 'ditto' signs or any other such convention to repeat a previous value. In many circumstances a blank will serve just as well. If it won't, then repeat the value.

A frequently seen mistake is to use '\begin{center}' . . . '\end{center}' inside a figure or table environment. This center environment can cause additional vertical space. If you want to avoid that just use '\centering'

Table 3.1 A badly formatted table

| Dental measurement | Species I | | Species II | |
|---|---|---|---|---|
| | mean | SD | mean | SD |
| I1MD | 6.23 | 0.91 | 5.2 | 0.7 |
| I1LL | 7.48 | 0.56 | 8.7 | 0.71 |
| I2MD | 3.99 | 0.63 | 4.22 | 0.54 |
| I2LL | 6.81 | 0.02 | 6.66 | 0.01 |
| CMD | 13.47 | 0.09 | 10.55 | 0.05 |
| CBL | 11.88 | 0.05 | 13.11 | 0.04 |

Table 3.2 A nice looking table

| Dental measurement | Species I | | Species II | |
|---|---|---|---|---|
| | mean | SD | mean | SD |
| I1MD | 6.23 | 0.91 | 5.2 | 0.7 |
| I1LL | 7.48 | 0.56 | 8.7 | 0.71 |
| I2MD | 3.99 | 0.63 | 4.22 | 0.54 |
| I2LL | 6.81 | 0.02 | 6.66 | 0.01 |
| CMD | 13.47 | 0.09 | 10.55 | 0.05 |
| CBL | 11.88 | 0.05 | 13.11 | 0.04 |

Table 3.3 Even better looking table using booktabs

| Dental measurement | Species I | | Species II | |
|---|---|---|---|---|
| | mean | SD | mean | SD |
| I1MD | 6.23 | 0.91 | 5.2 | 0.7 |
| I1LL | 7.48 | 0.56 | 8.7 | 0.71 |
| I2MD | 3.99 | 0.63 | 4.22 | 0.54 |
| I2LL | 6.81 | 0.02 | 6.66 | 0.01 |
| CMD | 13.47 | 0.09 | 10.55 | 0.05 |
| CBL | 11.88 | 0.05 | 13.11 | 0.04 |

### 3.3.1 ctable

You can use ctable package to create highly customizable tables. Check documentation for further explanation

Table 3.4 The Skewing Angles ($\beta$) for
$Mu(H) + X_2$ and $Mu(H) + HX$ $^a$

|  | $H(Mu) + F_2$ | $H(Mu) + Cl_2$ |
| --- | --- | --- |
| $\beta(H)$ | $80.9^{\circ b}$ | $83.2^\circ$ |
| $\beta(Mu)$ | $86.7^\circ$ | $87.7^\circ$ |

$^a$ for the abstraction reaction,
$Mu + HX \rightarrow MuH + X$.
$^b$ 1 degree $= \pi/180$ radians.
$^c$ this is a particularly long note, showing that
footnotes are set in raggedright mode as we
don't like hyphenation in table footnotes.

### 3.3.2 lenghty table that cover whole width

In case of double column layout, tables which do not fit in single column width should be set to full text width. For this, you need to use `\begin{table*} ... \end{table*}` instead of `\begin{table} ... \end{table}` environment. confirm if footnotes are getting printed and find a fix if not.

Table 3.5 Example of a lengthy table which is set to full textwidth

| Project | Element 1[a] | | | Element 2[b] | | |
| --- | --- | --- | --- | --- | --- | --- |
|  | Energy | $\sigma_{calc}$ | $\sigma_{expt}$ | Energy | $\sigma_{calc}$ | $\sigma_{expt}$ |
| Element 3 | 990 A | 1168 | $1547 \pm 12$ | 780 A | 1166 | $1239 \pm 100$ |
| Element 4 | 500 A | 961 | $922 \pm 10$ | 900 A | 1268 | $1092 \pm 40$ |

### 3.3.3 sideways table

You can use sideways environment to create sideways table to carry more data in a single page.

Table 3.6 Tables which are too long to fit, should be written using the "sidewaystable" environment as shown here

| Projectile | Element 1[a] | | | Element[b] | | |
|---|---|---|---|---|---|---|
| | Energy | $\sigma_{calc}$ | $\sigma_{expt}$ | Energy | $\sigma_{calc}$ | $\sigma_{expt}$ |
| Element 3 | 990 A | 1168 | $1547 \pm 12$ | 780 A | 1166 | $1239 \pm 100$ |
| Element 4 | 500 A | 961 | $922 \pm 10$ | 900 A | 1268 | $1092 \pm 40$ |
| Element 5 | 990 A | 1168 | $1547 \pm 12$ | 780 A | 1166 | $1239 \pm 100$ |
| Element 6 | 500 A | 961 | $922 \pm 10$ | 900 A | 1268 | $1092 \pm 40$ |

Note: This is an example of table footnote this is an example of table footnote this is an example of table footnote this is an example of table footnote this is an example of table footnote.

[a]This is an example of table footnote.

[b]A very important table footnote

## 3.4  Equations

Equations in LaTeX can either be inline or on-a-line by itself ("display equations"). For inline equations use the `$...$` commands. E.g.: The equation $H\psi = E\psi$ is written via the command `$H \psi = E \psi$`.

For display equations (with auto generated equation numbers) one can use the equation or align environments:

$$\|\tilde{X}(k)\|^2 \leq \frac{\sum\limits_{i=1}^{p} \|\tilde{Y}_i(k)\|^2 + \sum\limits_{j=1}^{q} \|\tilde{Z}_j(k)\|^2}{p+q}. \tag{3.1}$$

where,

$$D_\mu = \partial_\mu - ig\frac{\lambda^a}{2}A_\mu^a$$
$$F_{\mu\nu}^a = \partial_\mu A_\nu^a - \partial_\nu A_\mu^a + gf^{abc}A_\mu^b A_\nu^a \tag{3.2}$$

Notice the use of `\nonumber` in the align environment at the end of each line, except the last, so as not to produce equation numbers on lines where no equation numbers are required. The `\label{}` command should only be used at the last line of an align environment where `\nonumber` is not used.

$$Y_\infty = \left(\frac{m}{\text{GeV}}\right)^{-3}\left[1 + \frac{3\ln(m/\text{GeV})}{15} + \frac{\ln(c_2/5)}{15}\right] \tag{3.3}$$

# Journal publications

[1] **Rop Aron**, Nagy T., and L. G. N. Paper Title. *Journal Name*, VOL(NUMBER), PP-PP, YEAR.

# Full papers in conference proceedings

[5] **Rop Aron**, G. W, P. V, H.B. R, M. M, Á. L. Paper Title. In *Proceedings of the Xth Annual International Conference on Conference*, DISTRIBUTOR, PP-PP, YEAR.

# Further related publications

[8] **Rop Aron**, A. B, G. K, G. H, and L. G. N. Paper Title. In *The Xth Jubilee Conference of Something: Volume of extended abstracts.*, YEAR.

# References

[1] B. Aupetit. *A Primer on Spectral Theory*. Springer-Verlag, New York, 1991.

[2] Y. A. Abramovich, C. D. Aliprantis, and O. Burkinshaw. Another characterization of the invariant subspace problem. *Operator Theory in Function Spaces and Banach Lattices. The A.C. Zaanen Anniversary Volume, Operator Theory: Advances and Applications*, 75:15–31, 1995. Birkhäuser Verlag.

[3] J. B. Conway. *Functions of One Complex Variable*. Springer-Verlag, New York, 1978.

[4] J. Daughtry. An invariant subspace theorem. *Proc. Amer. Math. Soc.*, 49:267–268, 1975.

[5] Christophe Ancey, Philippe Coussot, and Pierre Evesque. Examination of the possibility of a fluid-mechanics treatment of dense granular flows. *Mechanics of Cohesive-frictional Materials*, 1(4):385–403, 1996.

[6] C. J. Read. A solution to the invariant subspace problem on the space $l_1$. *Bull. London Math. Soc.*, 17:305–317, 1985.

# Index

LaTeX class file,