# Methylene volumes in monoglyceride bilayers are larger than in liquid alkanes.

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## Introduction

Lipids are biologically relevant molecules being the main component of a cell membrane. Additionally, lipids are used for the production of many goods in various ways. For example they are used as surfactants in cosmetics and emulsifiers in food. Having a understanding of the physical properties of these molecules may allow us to understand their function in broader contexts.

We studied the lipids monomyristin, monolaurin, monocaprin, and monocaprylin. These molecules are composed of a non-polar hydrocarbon tail and a polar head group, and they will self-assemble into various structures.

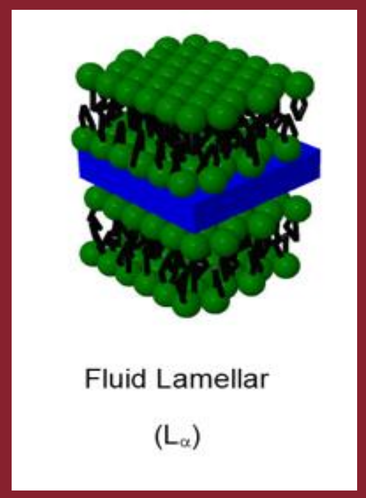


Fig. 1 The image to the left displays a lipid bilayer in the fluid lamellar phase. It gets this naming because the lipids are free to move like a fluid in the plane of the stacked [lamellar] lipid molecule sheets.

## Goals

- Compare and contrast the volume of a methylene group in bilayers and in alkanes
- Compare the volumes of methylene groups in bilayers of different lipids.

## Volume Measurements

- Data taken by vibrating tube densitometry
- The instrument measures the frequency of oscillation of a sample, from which the density (and therefore the volume) can be calculated.
- Volume data taken by our colleagues at Carnegie Mellon University.

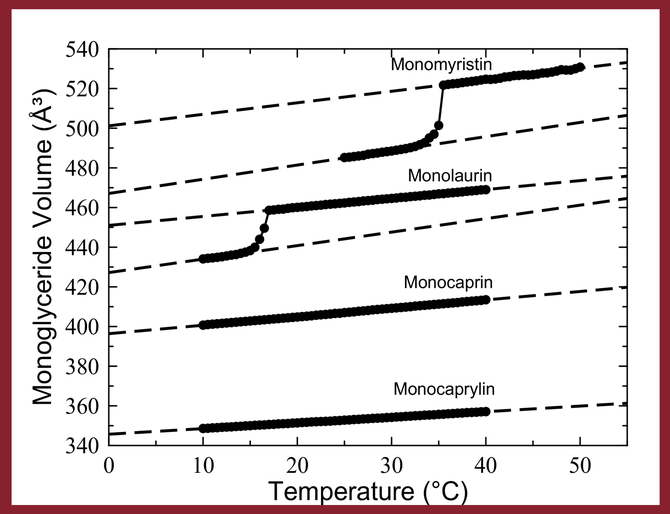


Fig. 2 The graph above plots the volumes of four monoglycerides as a function of temperature. Within a given lamellar phase the volumes increase linearly with temperature. Note that monocaprylin is in an unknown phase.

## References

T. S. Banipal, S. K. Garg, and J. C. Ahluwalia, The Journal of Chemical Thermodynamics 23,
923 (1991).
D. Uhrikova, P. Rybar, T. Hianik, and P. Balgav, Chemistry and Physics of Lipids 145, 97
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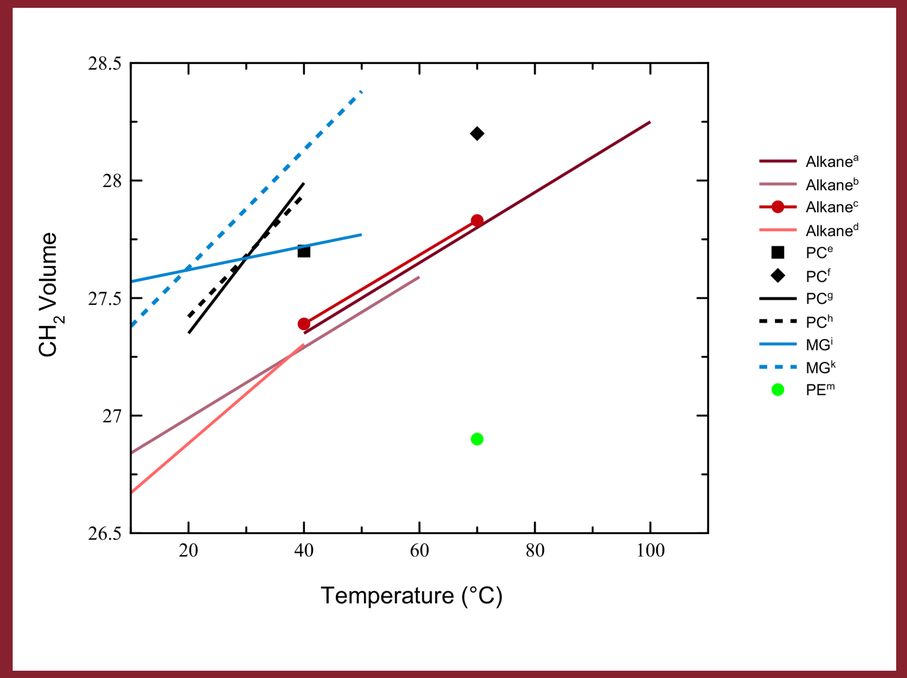


Fig. 3 The volume per methylene group as a function of temperature. Methylene volumes from different lipid systems are color coded. Alkane, PC (phosphatidylcholine), MG (monoglyceride) and PE (phosphatidylethanolamine) are, respectively, red, black, blue, and green. [a]Our fit of the alkane data from Banipal et al. [b]Data taken by Tristam-Nagel and this line is a part of this work, and not from a previous publication. [c]Two data points from Rossini as quoted by Marsh and a linear regression line fit to these points. [d]Data from Table 5 in Koenig and Gawrisch's paper. [e]Data point from Yang et al. as quoted by Marsh. [f]Data point from Schmidt and Knoll as quoted by Marsh. [g]Data from Table 2 in Uhrikova et al. [h]Adjustment to Uhrikova's data without the assumption VCH3 = 2VCH2. [i]Data for the monoglycerides studied in this work. [k]Adjustment applied to our data assuming the remainder term is the compound monoacetin. [m]Data from Koynova and Hinz as quoted by Marsh. The main oddity in the graph is the lone PE data point taken from Marsh, whose methods to extract said data point are not extrapolated upon by him, but reported in Table 1 of his paper.

## Conclusions

- The data presented suggests a consensus on the volume of a methylene group in liquid alkanes.
- We find the volume of a methylene group in a monoglyceride bilayer is 2 percent larger than in liquid alkanes, matching the methylene group volumes found in PC bilayers.