Thermophoresis of cyclodextrins with/without aspirin in water

K. Eguchi[1], D. Niether[2] , J. Hovancova[3] , T. Kawaguchi [1] , R. Kita[1] and S. Wiegand[2,4]

[1]*School of Science, Tokai University, Hiratsuka Kanagawa 259-1292, Japan*

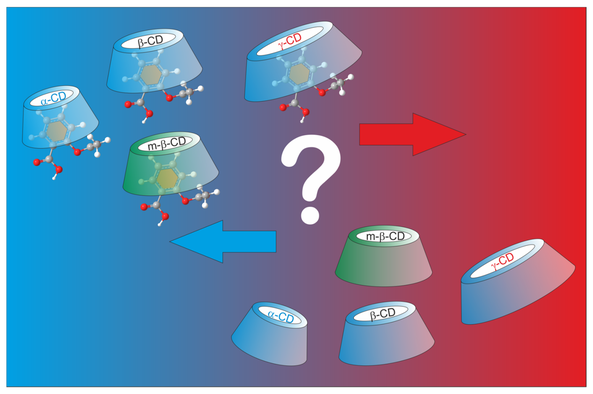
[2]*ICS-3 Soft Condensed Matter, Forschungszentrum Jülich GmbH, D-52428 Jülich, Germany*

[3]*Chemistry Department, Pavol Jozef Šafárik Univerzity, Košice, Slovakia*

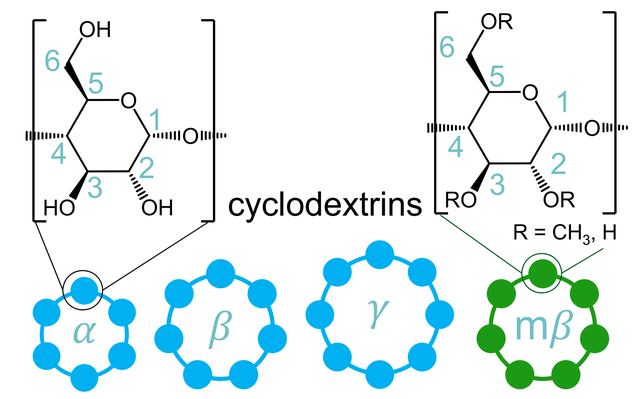
[4]*Chemistry Department – Physical Chemistry, University Cologne, D-50939 Cologne, Germany*

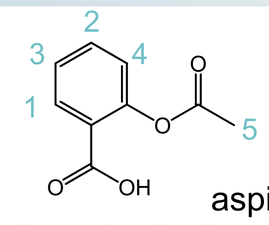
Motivation [1]

- Controlled movement of drugs into certain, e.g. inflamed, areas
- Check complex formation: α-, β-, γ- and methyl-β-cyclodextrin with aspirin by NMR
- investigation of thermophoretic behavior



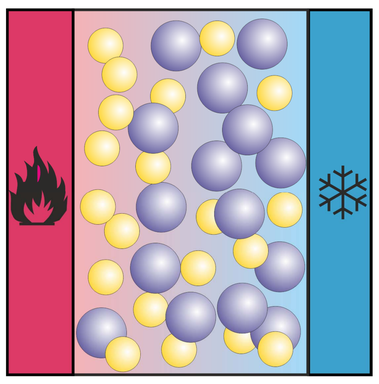
System





concentration: 1wt% CD
molar 1:1-ratio: CD:aspirin

Thermophoresis [2]



Flux $\vec{j}$ along a temperature gradient:

(1) thermal diffusion D_T along a temperature gradient ∇T

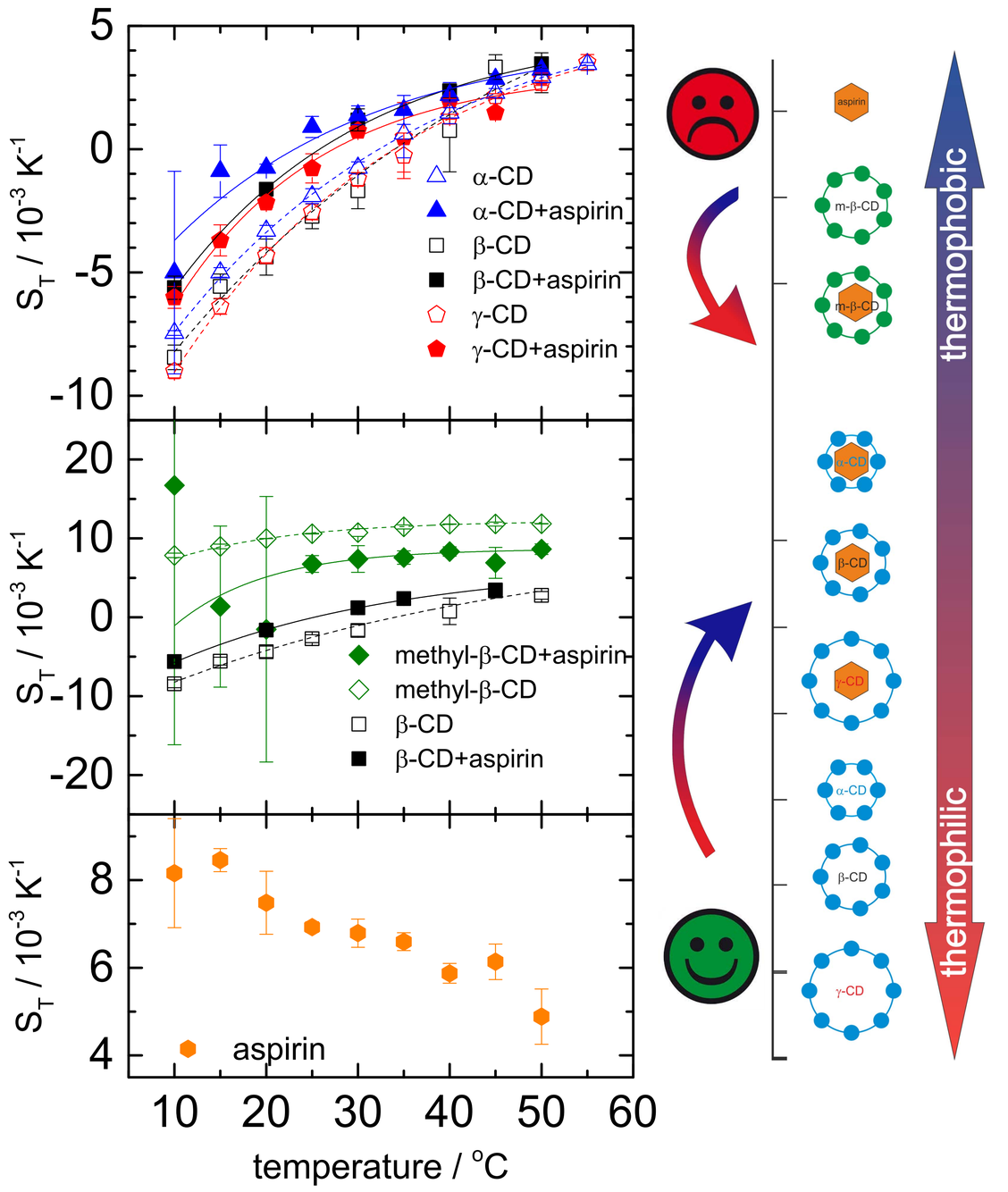
(2) Fickian diffusion D along the induced concentration gradient ∇c.

$$\vec{j} = -D\vec{\nabla}c - c(1-c)D_T\vec{\nabla}T$$

In the steady state (j=0) the Soret coefficient S_T is defined

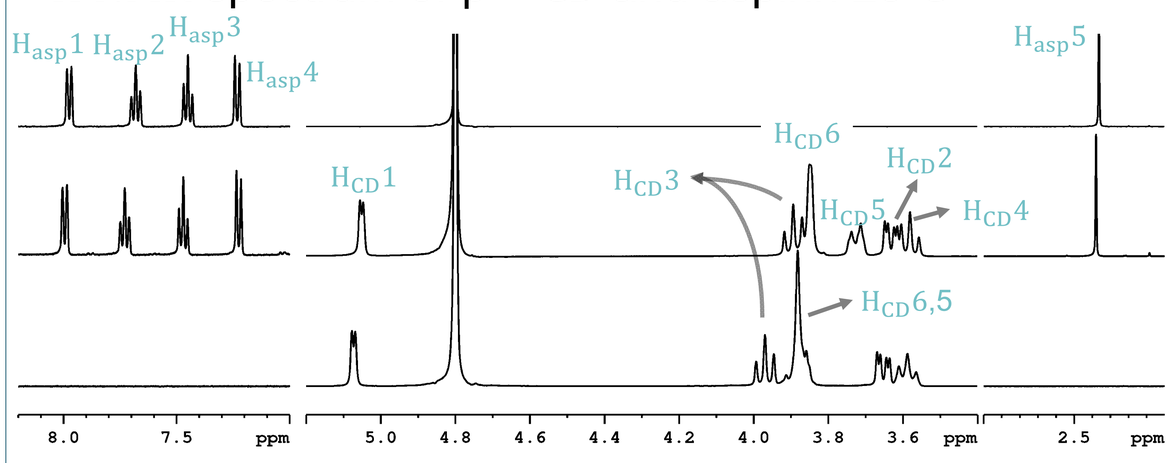
$$S_T \equiv \frac{D_T}{D} = -\frac{1}{c(1-c)}\frac{\Delta c}{\Delta T}$$

TDFRS results [3]

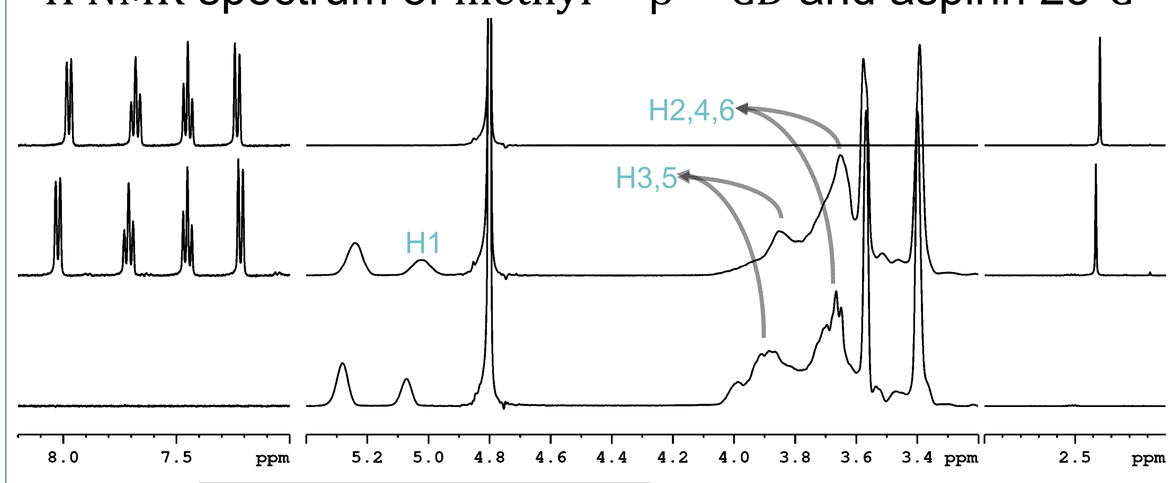


NMR measurements [4], [6]

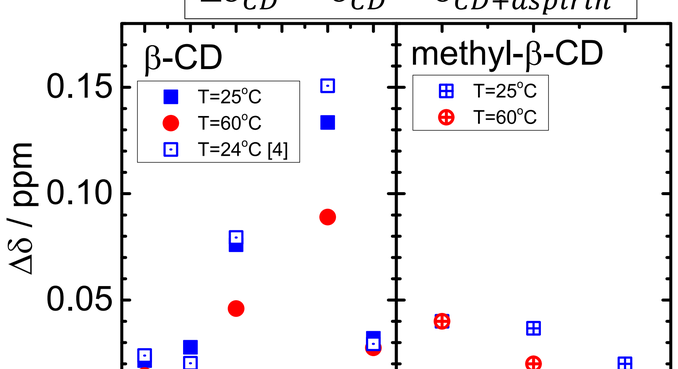
^{1}H NMR spectrum of β − CD and aspirin 25°C

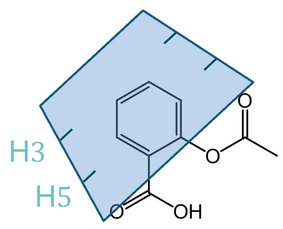


^{1}H NMR spectrum of methyl − β − CD and aspirin 25°C



$$\Delta\delta_{CD} = \delta_{CD} - \delta_{CD+aspirin}$$





Magnetic field of inwards pointing protons (H3 and H5) is influenced by aspirin(guest molecule).

β − CD

- large Δδ value is observed for H3 and H5 compared to the other protons.
- Δδ value of H3 and H5 is decreased by heating.

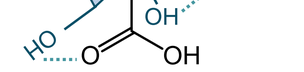
methyl − β − CD

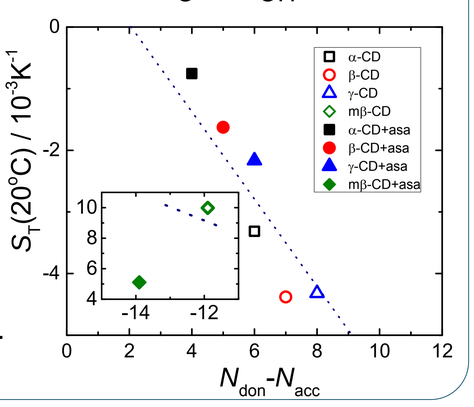
- small Δδ value observed for H3,5 compared to β − CDs H3 and H5.
- Δδ value of H3,5 is decreased by heating.

Inclusion complex is confirmed for both CDs.

Conclusion

- complexes formation are confirmed between CD and aspirin from NMR measurement
- At the high temperature the complex capability weakens
- behaviour of pure CDs and un-methylated CD-complexes fits donor-acceptor model[5]
- fewer HB sites result in a higher S_T/stronger thermophobicity
- drug-complex of methyl-β-CD behaves different
- possible explanations are polarisation or charge effects
- more information about structure of methyl-β-CD-complex is needed





References

[1] Del Valle, E.M.M., Process Biochemistry **39** (2004) 1033.
[2] Wiegand, S., in Functional Soft Matter, J.K.G. Dhont, et al., Editors. 2015, FZJ. F4
[3] Eguchi, K. *et al*., Eur. Phys. J. E (2016) accepted
[4] Loftsson, T *et al*., Eur. J. Pharma. Sci, **1** (1993) 95.
[5] Maeda, K. *et al.,* J. Chem. Phys., **143** (2015) 124504
[6] Wang, D.-W. *et al*.., Carbohyd. Polym., **93**(2013) 753