many new 3D (or 2D) nets may be anticipated.

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Supplementary Material Available: Crystal data and data collection, structure determination and refinement, numbering scheme, and tables of crystal data and structure determination, fractional atomic coordinates and isotropic thermal parameters, and interatomic distances and angles for (Pd·py·porph)·2Cd(NO_3)$_2$·hydrate (9 pages); listing of observed and calculated structure factors (5 pages). Ordering information is given on any current masthead page.

Urea Transport by Macrocyclic Carriers through a Supported Liquid Membrane

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Macrocyclic receptor molecules like crown ethers and calixarenes can be used for the selective transport of cations through bulk and supported liquid membranes.[1-7] In this communication we report the transport of urea in its neutral form through a supported liquid membrane assisted by macrocyclic receptor molecules. To the best of our knowledge this is the first example of transport of neutral molecules through supported liquid membranes by macrocyclic carriers. Only recently examples of assisted transport of neutral molecules through supported liquid membranes have been known.[8,9] Yoshikawa et al. have employed the formation of a covalent bond between the carrier and the guest to transport amines.[8] Pirkle and Doherty have used a lipophilic amino ester for the enantioselective transport of amino esters or amides across a swollen silicone rubber.[9]

Selective urea removal is of great importance in medicine. Crown ethers are known to form weak complexes with urea.[10,11] Searching for macrocyclic receptor molecules that complex urea well and can be used as selective carriers in supported liquid membranes, we have developed crown ethers with intraannular acidic groups (COOH, SO_3H) which result in a strong interaction with urea.[12,13] However, these receptor molecules have very low partition coefficients (log $P < 1$) and are therefore not suitable as carriers in supported liquid membranes.[6,7,14,15] To improve the lipophilicity, several metallomacrocycles containing a salophene moiety[16,17] have been prepared which complex urea well by coordination of the urea carbonyl to UO_2, which is complexed by

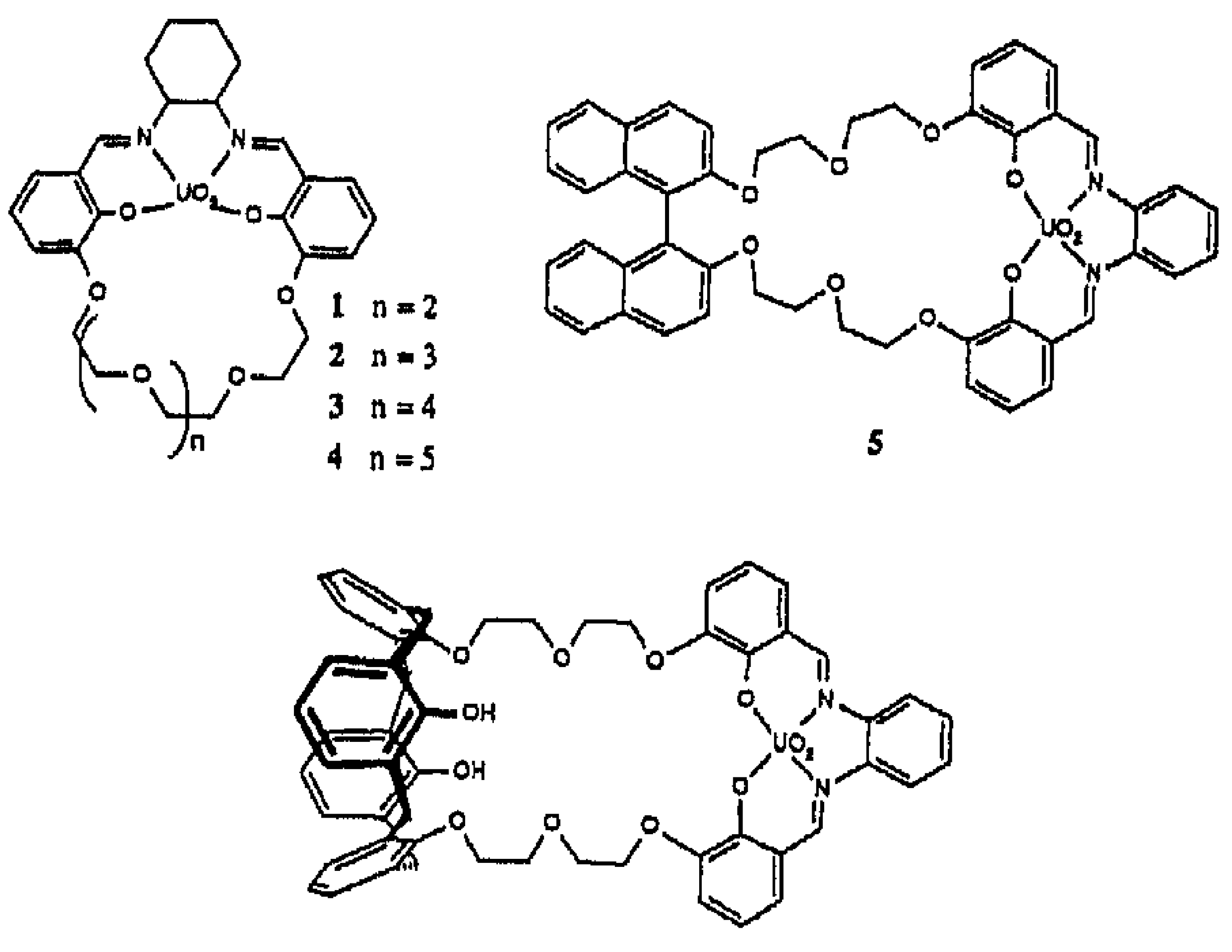

Figure 1. Structures of macrocyclic carriers used for urea transport.

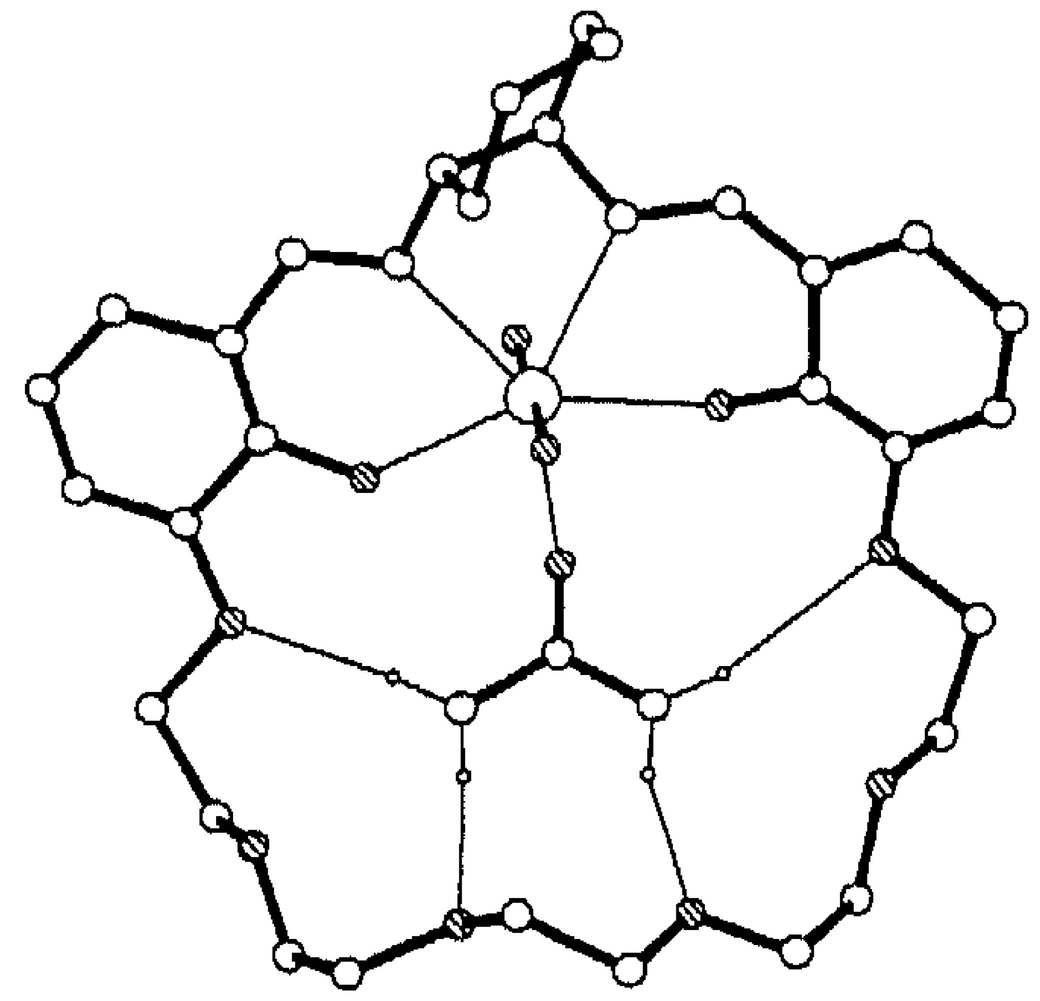

Figure 2. Crystal structure of 2-urea.

Table I. Urea Fluxes[a] through a Supported Liquid Membrane Measured for Different Metallomacrocyclic Carriers

carrier	carrier concn, mM	flux 1	flux 2	flux 3
–	–	1.6		
1	6.9	2.3		
2	6.0	20.6	10.8	6.8
	2.8	12.0		
3	6.1	8.4		
4	2.8[b]	5.9		
5	6.0	22.2	22.7	23.0
6	6.3	20.0	20.2	20.5

[a] Initial fluxes (in units of 10^{-8} mol cm^{-2} h^{-1}) given after no replacements (flux 1), one replacement (flux 2) and two replacements (flux 3) of the receiving phase; source phase = 1 M urea; 298 K. [b] Saturated carrier solution.

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the salophene moiety, and hydrogen bonding between the NH_2 functions of urea and the oxygens of the ethylene glycol bridge of the host. However, these compounds are only poorly soluble in most solvents. Therefore these receptors were further modified by replacing the benzene ring of the salophene by a 1,2-cyclohexyl moiety to obtain more soluble receptors (**1–4**).[18] Compounds **1–4** were prepared from the corresponding dialdehydes and *cis*-1,2-cyclohexanediamine in methanol according to the route outlined for the corresponding salophene metallomacrocycles in ref 17 (see Figure 1).

These compounds have been used as carriers in a supported liquid membrane composed of a porous polymeric support (Accurel) impregnated with *o*-nitrophenyl *n*-octyl ether (NPOE)[4,6,7] to investigate the relation between the ring size of the metallomacrocycle and the rate of urea transport.[19] Since the partition of these carriers might still be rather low, crown ether salophene derivatives have been modified with a binaphthyl (**5**) or a calix[4]arene (**6**) function to obtain a lipophilic and selective urea carrier. Compounds **5** and **6** were prepared from the corresponding dialdehydes and 1,2-benzenediamine in THF according to ref 17.[20]

Table I shows that the urea fluxes using the cyclohexyl receptors (**1–4**) depend strongly on the ring size of these carriers. Compound **1** results in a urea flux (2.3×10^{-8} mol cm^{-2} h^{-1}) that is comparable to the blank flux observed in experiments where no carrier is used (1.6×10^{-8} mol cm^{-2} h^{-1}), while the larger rings transport urea much better, especially compound **2** ($n = 3$). With this compound the urea flux (20.6×10^{-8} mol cm^{-2} h^{-1}) is 13 times higher than the blank flux and also higher than fluxes obtained by using comparable concentrations of compounds **1** (2.3×10^{-8} mol cm^{-2} h^{-1}) and **3** (8.4×10^{-8} mol cm^{-2} h^{-1}).[24] Compound **4** is only poorly soluble in NPOE and results also in a lower flux (5.9×10^{-8} mol cm^{-2} h^{-1} when a 2.8 mM solution is used compared to 12.0×10^{-8} mol cm^{-2} h^{-1} when the same concentration of **2** is used). The different rates of transport are in agreement with CPK models, which show that compound **1** has a cavity that is too small to complex urea and which show the best fit for compound **2** (see Figure 2 for the X-ray crystal structure).[18]

Table I also shows that, upon replacement of the receiving aqueous phase one and two times respectively, the flux for the cyclohexyl carrier **2** decreases from 20.6 to 10.8 and 6.8×10^{-8} mol cm^{-2} h^{-1}. This means that the carrier leaches out to the aqueous phases. This is not observed for the binaphthyl **5** or calix[4]arene **6** modified carriers. In these cases the urea fluxes (22.2×10^{-8} mol cm^{-2} h^{-1} for **5** and 20.0×10^{-8} mol cm^{-2} h^{-1} for **6**) are comparable to those obtained with carrier **2** but do not decrease upon replacement of the receiving aqueous phase, so that when more lipophilic carriers are used, a stable membrane is obtained.

In summary: neutral molecules like urea can be transported by macrocyclic carriers through supported liquid membranes. High fluxes can be obtained by using carriers that possess a cavity in which the guest molecule fits well. The membrane stability can be much improved by using carriers modified with lipophilic groups like binaphthyl or calixarene units. In the future the transport selectivity for urea will be studied by competition experiments. A transport model which was previously developed for cation transport[4,6,7] can be modified to describe the transport of neutral molecules.

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(18) Details of the synthesis and the crystal structure will be published: van Doorn, A. R.; Schaafstra, R.; Bos, M.; van Eerden, J.; Harkema, S.; Verboom, W.; Reinhoudt, D. N., in preparation.

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$$J = \frac{D_m K_{ex}[U]_w^\circ [C]_m^\circ}{d\{P + QK_{ex}[U]_w^\circ\}}$$

in which D_m = diffusion coefficient of the complex, K_{ex} = extraction coefficient, $[U]_w^\circ$ = initial urea concentration in the source phase, $[C]_m^\circ$ = initial carrier concentration in the membrane, d = membrane thickness, $P = 1 + V_r V_m^{-1} K_c^{-1} + V_s V_m^{-1} K_c^{-1}$, $Q = 1 + V_r V_m^{-1} K_c^{-1} + K_w V_s V_m^{-1} K_c^{-1} K_{ex}^{-1}$, V_r = volume receiving phase, V_s = volume source phase, V_m = membrane volume, K_c = partition coefficient of the carrier, and K_w = association constant in water. Substantiation of this model will be the subject of a future publication.

A Simple, Effective Method for Achieving High 1,4-Relative Asymmetric Induction in Carbonyl Addition Reactions

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One of the most challenging problems in practical organic synthesis is the stereocontrolled installation of new stereogénic centers at sites far removed from existing stereocenters in acyclic molecules.[2] Herein we report a unique approach to 1,4-relative asymmetric induction in which neighboring-group participation[3] is postulated as the foundation for high levels of remote asymmetric induction (Scheme I).

In initial studies testing this hypothesis, the combination of trimethylsilyl cyanide (TMSCN) as the nucleophile and trimethylsilyl trifluoromethanesulfonate (TMSOTf)[4] as the Lewis acid catalyst was chosen for investigation in conjunction with acetal electrophiles. When dimethoxy acetals were utilized as substrates, disappointingly low diastereoselectivities were observed (Table I, entry 1).[5] Because the nature of the acetal was expected to be an important factor in determining the diastereoselectivity for

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