Appendix 1b

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Development of methods for the synthesis of (poly)functionalized heterocycles based on exploration of alkoxyallenes, nitrones, and imidazole *N*-oxides

Summary of professional accomplishments

Łódź, 2016

1. Name and surname

Marcin Jasiński

2. Scientific diploma and degrees

2008 University of Łódź
Faculty of Chemistry
Graduated degree: PhD in Chemistry
Supervisor: prof. dr hab. Grzegorz Mlostoń

Title of the PhD thesis: *Studies on synthesis of imidazole derivatives based on exploration of diamines, amino alcohols, and amino acids* (the thesis awarded by Council of the Faculty of Chemistry, University of Łódź and by the Sigma-Aldrich and Polish Chemical Society Distinction for the best PhD thesis in organic chemistry defended in 2008)

2004 University of Łódź
Faculty of Chemistry and Physics
Graduated diploma: MSc
Supervisor: prof. dr hab. Grzegorz Mlostoń

Title of the MSc thesis: *New imidazole N-oxides derived from natural amino acids*

3. History of employments

since 2008
University of Łódź
Faculty of Chemistry
Department of Organic and Applied Chemistry
Position: assistant professor

2005-2007
University of Łódź
Faculty of Chemistry and Physics
Department of Organic and Applied Chemistry
Position: assistant

4. Summary of scientific achievements*

(*until March 22nd, 2016)

- 36 scientific publications, including: 34 papers published in journals of the *ISI Master Journal List*, 32 original papers, 2 reviews, 2 conference communications; 13 publications as a first author, 11 papers as a corresponding author

- after receiving PhD degree: 29 publications, including 10 papers as a first author and 10 papers as a corresponding author

- the sum of impact factor values according to JCR Journal Citation Reports (JCR) list; IF values according to year of publication: IF = 87.746

- the sum of the Ministry of Science and Higher Education points: 935 pkt. (according to parts A and B of the most recent list published in 2015)

- number of citations: 281 (according to Scopus), 268 (according to Web of Science); without self-citations: 197 and 190 (Scopus and Web of Science, respectively)

- Hirsch index (according to Scopus) h = 10

5. Indication of achievements according to Article. 16 Paragraph 2 of the Act of Laws from 14 March 2003 on Academic Degrees (Journal of Laws no. 65, item 595 as amended)

5.1. Title

Development of methods for the synthesis of (poly)functionalized heterocycles based on exploration of alkoxyallenes, nitrones, and imidazole *N*-oxides

5.2. List of publications

H1 Three-step synthesis of 3-aminoseptanoside derivatives by using lithiated methoxyallene and δ-siloxynitrones

M. Jasiński*, G. Utecht, A. Fruziński, H.-U. Reissig, *Synthesis* **2016**, 48, 893–905 (IF_{2015} = 2.689)

My contribution to this publication consisted of: design of the structures and the synthetic strategies towards title compounds, and their further transformations (planned and performed on the basis of Ministry of Science and Higher Education grant 'Iuventus Plus'); initial syntheses, optimizations and the partially preparation of the final compounds, analysis of the results, preparation of the manuscript, correspondence with the editor and the preparation of the final publication. My estimated contribution is calculated to 70%.

H2 Anion alkoksyallenowy w syntezie związków naturalnych i ich analogów

B. Busiak, G. Utecht, M. Jasiński*, *Wiad. Chem.* **2016**, *70*, 3–23 ($MNiSW_{2015}$ = 7 pkt)

My contribution to this publication consisted of: proposal of the reviews' title and the preparation of the first draft of the manuscript (performed on the basis of Ministry of Science and Higher Education grant 'Iuventus Plus'), correspondence with the editor and the preparation of the final publication. My estimated contribution is calculated to 70%.

H3 Recent progress in the chemistry of 2-unsubstituted 1*H*-imidazole 3-oxides

G. Mlostoń*, M. Jasiński, A. Wróblewska, H. Heimgartner*, *Curr. Org. Chem.* **2016**, doi:10.2174/1385272820666151210000010 (IF_{2015} = 2.117)

My contribution to this publication consisted of: participation in the preparation of the first draft of the manuscript, further corrections and the preparation of the final publication. My estimated contribution is calculated to 35%.

H4 Synthesis of aldopentapyranose-derived nitrones by silylation or Cu(II)-catalyzed aerobic oxidation of *N*-glycosylhydroxylamines

J. Maciaszczyk, M. Jasiński*, *Tetrahedron: Asymmetry* **2015**, *26*, 510–515 (IF_{2015} = 2.155)

My contribution to this publication consisted of: design of the structures and the synthetic strategies towards title compounds (planned and performed on the basis of Ministry of Science and Higher Education grant 'Iuventus Plus'), initial syntheses, optimizations and preparation (in part) of the final compounds, analysis of the results, preparation of the manuscript, correspondence with the editor and the preparation of the final publication. My estimated contribution is calculated to 80%.

H5 Reactions of cycloaliphatic thioketones and their oxo analogues with lithiated methoxyallene: A new approach to vinylthiiranes

M. Jasiński*, G. Mlostoń*, M. Stolarski, W. Costa, M. Domínguez, H.-U. Reissig*, *Chem. Asian J.* **2014**, *9*, 2641–2648 (IF_{2014} = 4.587)

My contribution to this publication consisted of: design of the synthetic strategies and further transformations of title tiiranes into adamantane-derived compounds, optimization studies and synthesis of all compounds described in this paper, analysis of the results, preparation of draft and

further corrections of the manuscript and participation in the preparation of its final version. My estimated contribution is calculated to 50%.

H6 Synthesis of a series of enantiopure polyhydroxylated bicyclic *N*-heterocycles from an L-erythrose derived nitrone and alkoxyallenes

M. Jasiński, E. Moreno-Clavijo, H.-U. Reissig*, *Eur. J. Org. Chem.* **2014**, 442–454 (IF_{2014} = 3.065)

My contribution to this publication consisted of: design of the structures and elaboration of the synthetic strategies for the preparation of title compounds, and their further transformations (planned and performed on the basis of Foundation for Polish Science post-doc grant 'Kolumb'); optimizations and the synthesis of all compounds, analysis of the results, preparation of draft version and its further corrections. My estimated contribution is calculated to 50%.

H7 Samarium diiodide promoted reduction of 3,6-dihydro-2*H*-1,2-oxazines: Competition of 1,4-amino alcohol formation and ring contraction to pyrrole derivatives

M. Jasiński, T. Watanabe, H.-U. Reissig*, *Eur. J. Org. Chem.* **2013**, 605–610 (IF_{2013} = 3.154)

My contribution to this publication consisted of: design of the structures and elaboration of the synthetic strategies for the preparation of title compounds, and their further transformations (planned and performed on the basis of Foundation for Polish Science post-doc grant 'Kolumb'); optimizations of procedures and the synthesis of all compounds, analysis of the results, preparation of draft version and its further corrections. My estimated contribution is calculated to 50%.

H8 Carbohydrate-auxiliary assisted preparation of enantiopure 1,2-oxazine derivatives and aminopolyols

M. Jasiński, D. Lentz, H.-U. Reissig*, *Beilstein J. Org. Chem.* **2012**, *8*, 662–674 (IF_{2012} = 2.801)

My contribution to this publication consisted of: design of the structures and elaboration of the synthetic strategies for the preparation of title compounds, and their further transformations (planned and performed on the basis of Foundation for Polish Science post-doc grant 'Kolumb'); optimizations of procedures and the synthesis of all compounds, analysis of the results including mechanisms and stereochemical problems, preparation of draft version and its further corrections. My estimated contribution is calculated to 60%.

H9 Application of L-erythrose-derived nitrones in the synthesis of polyhydroxylated compounds *via* 3,6-dihydro-2*H*-1,2-oxazine derivatives

M. Jasiński, D. Lentz, E. Moreno-Clavijo, H.-U. Reissig*, *Eur. J. Org. Chem.* **2012**, 3304–3316 (IF_{2012} = 3.344)

My contribution to this publication consisted of: design of the structures and elaboration of the synthetic strategies for the preparation of title compounds, and their further transformations (planned and performed on the basis of Foundation for Polish Science post-doc grant 'Kolumb'); optimizations of procedures and the synthesis of all compounds, analysis of the results including stereochemical problems, formulation of the reaction mechanisms, preparation of draft version and its further corrections. My estimated contribution is calculated to 50%.

H10 Optically active imidazoles derived from enantiomerically pure *trans*-1,2-diaminocyclohexane

G. Mlostoń*, D. Rygielska, M. Jasiński*, H. Heimgartner, *Tetrahedron: Asymmetry* **2011**, *22*, 669–674 (IF_{2011} = 2.652)

My contribution to this publication consisted of: design of the structures and elaboration of the synthetic strategies for the preparation of title compounds, and their further transformations, initial syntheses, optimizations of procedures, analysis of the results, preparation of draft version and the final publication. My estimated contribution is calculated to 50%.

H11 Synthesis of new imidazole 3-oxides; Unexpected deoxygenation of some derivatives in the reaction with 2,2,4,4-tetramethylcyclobutane-1,3-dithione

G. Mlostoń*, M. Jasiński, D. Rygielska, H. Heimgartner*, *Heterocycles* **2011**, *83*, 765–776 (IF_{2011} = 0.999)

My contribution to this publication consisted of: initial syntheses, analysis of the results, and the preparation of the draft version of the publication. My estimated contribution is calculated to 30%.

H12 Straightforward access to (imidazol-2-yl)acetates by reaction of 2-unsubstituted imidazole 3-oxides with dimethyl acetylenedicarboxylate

G. Mlostoń, M. Jasiński*, H. Heimgartner, *Eur. J. Org. Chem.* **2011**, 2542–2547 (IF_{2011} = 3.329)

My contribution to this publication consisted of: design of the structures and elaboration of the synthetic procedures applied for the preparation of title compounds, and their further transformations, optimizations of procedures and the synthesis of all compounds, analysis of the results and formulation of the postulated mechanism. Preparation of draft manuscript, correspondence with the editor, and the preparation of final version of the paper. My estimated contribution is calculated to 70%.

H13 Synthesis of 2,3-dihydro-imidazo[2,1-*b*]thiazole derivatives *via* cyclization of *N*-allylimidazoline-2-thiones

M. Jasiński, G. Mlostoń*, H. Heimgartner*, *J. Heterocycl. Chem.* **2010**, *47*, 1287–1293 (IF_{2010} = 0.962)

My contribution to this publication consisted of: design of the applied method, preparation and isolation of title compounds. Elaboration of their further transformations, optimizations of procedures and the synthesis of all compounds, analysis of the results, preparation of experimental part of the manuscript, further corrections and preparation of the final version. My estimated contribution is calculated to 70%.

5.3. Description of the scientific goals and results described in the series of publications forming the base of the Thesis

5.3.1. Introduction

It is well documented, that molecules containing multiple bonds exhibit diverse reactivities, and for that reason, (hetero)cumulenes are considered as extremely versatile class of substrates, which has been attracted attention of organic chemists since many decades. As a subclass of this group, relatively readily available allenes are recognized as important building blocks in the modern organic chemistry as well as attractive models for the studies focused on axial chirality.[1] Due to unique reactivity of the allenic unit, (hetero)cumulenes exhibit enormous potential for the preparation of various organic scaffolds and therefore, numerous target compounds of desired properties are available starting with the corresponding functionalized allenes. More than four decades after pioneer work by Arens and co-workers[2,3] a renaissance of interest in the chemistry of alkoxyallenes, and especially *in*

[1] *Modern Allene Chemistry*, Eds. N. Krause, A. S. K. Hashmi, Wiley-VCH,Weinheim 2004.
[2] *Preparation, metallation, and alkylation of allenyl ethers*, S. Hoff, L. Brandsma, J.F. Arens, *Recl. Trav. Chim. Pays-Bas*, **1968**, *87*, 916.
[3] *Base induced reactions of 1-alkoxy- or 1-methylthio-1-(α- or β-hydroxyalkyl)allenes. Formation of 3-alkoxy- and 3-methylthiodihydrofurans.* S. Hoff, L. Brandsma, J.F. Arens, *Recl. Trav. Chim. Pays-Bas*, **1969**, *88*, 609.

situ generated α-lithiated alkoxyallenes of type **1** has been observed. These highly reactive carboanions are prone substrates for the reactions with diverse electrophiles.[4] Particularly, carbonyl compounds such as aldehydes, ketones, and their derivatives (imines and nitrones) are the most often applied reagents towards lithiated alkoxyallenes. In addition, nitriles display also high reactivity towards anions **1**. Growing attention has also been paid to other electrophilic agents such as thioketones, carboxylic esters, alkyl halides as well as strained *N*- and *O*-heterocycles (aziridines and oxiranes). An important feature of the reactivity of lithiated alkoxyallene is smooth addition onto the carbonyl-derived electrophiles leading to the formation of intermediates (Fig. 1), which subsequently undergo spontaneous or induced cyclisation leading to polyfunctionalized heterocycles with diverse substitution pattern, not accessible by other procedures.

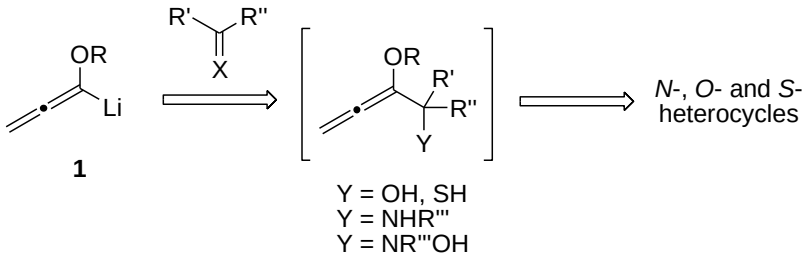


Fig. 1

An important group of reactions with lithiated alkoxyallenes relates to their additions to aldonitrones. Initial formation of the adduct is followed by 1,6-cyclisation leading to 3,6-dihydro-2*H*-1,2-oxazine derivatives (**2**) (Fig 2).[5] Main part of this summary is focused on selected problems resulting from transformations of that type. As demonstrated in Chapter 5.3.2, the presence of certain functional groups such as enol ether, N–O bond or substituents R' can open several options for further applications of products of type **2** in the preparation of more complex systems, including optically active natural products and their analogues. The utility of the latter class of compounds was recently summarized in a review dedicated to the Polish readers.[6]

In continuation of studies on reactivity of lithiated alkoxyallenes and their applications in organic synthesis, some attention has been paid to thioketones considered as an easily available *S*-containing electrophiles, which in the reactions with the title anions opened a new access to unusual, polyfunctionalized *S*-heterocyclic compounds, in most cases not available by standard synthetic protocols.

[4] *Alkoxyallenes as building blocks for organic synthesis*, R. Zimmer, H.-U. Reissig, *Chem. Soc. Rev.* **2014**, *43*, 2888.
[5] *A new diastereoselective synthesis of enantiomerically pure 1,2-oxazine derivatives by addition of lithiated methoxyallene to chiral nitrones*, W. Schade, H.-U. Reissig, *Synlett* **1999**, 632.
[6] *Anion alkoksyallenowy w syntezie związków naturalnych i ich analogów*, B. Busiak, G. Utecht, M. Jasiński, *Wiad. Chem.* **2016**, *70*, 3 [**H2**].

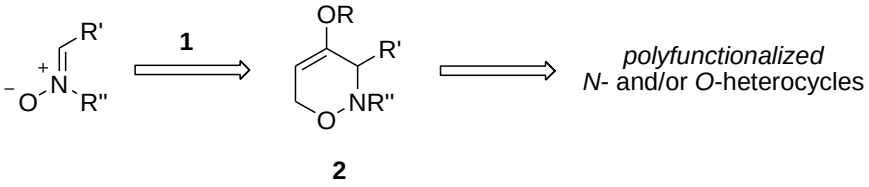


Fig. 2

Another relevant subject of the Thesis focuses on the synthesis and new transformations of 2-unsubstituted imidazole 3-oxides **3** as a subclass of azaaromatic *N*-oxides, which exhibit reactivity similar to that of aldonitrones. It is well known, that imidazole containing compounds belong to the most widespread nitrogen heterocycles in nature, which are incorporated into numerous pharmaceutics and biomolecules of general importance such as histidine (building block of enzymes and proteins) and purine, which is a nucleobase present in the structure of DNA and RNA.[7] Due to unique biological significance of imidazole derivatives, one of the main goals of modern organic synthesis relates to the chemistry of this heterocycle as evidenced by increasing number of original papers published by numerous groups including those working at the University of Łódź. As a part of our ongoing projects, the development of the synthetic tools for the preparation of more complex imidazole systems seems to be of special interest. In this context, as a part of the presented Thesis selected results related to the synthesis and applications of imidazole 3-oxides **3** (Fig. 3) in the preparation of the respective, (poly)functionalized imidazole systems are presented. Particular attention has been paid to the [3+2]-cycloadditions of 1,3-dipoles **3** with highly reactive dipolarophiles such as thioketones and activated acetylene derivatives. Very recently, most important aspects of the chemistry of 2-unsubstituted imidazole 3-oxides have been summarized in a review work.[8]

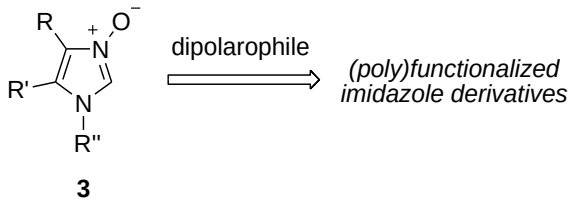


Fig. 3

[7] *Naturally occurring and synthetic imidazoles: their chemistry and their biological activities*, L. De Luca, *Curr. Med. Chem.* **2006**, *13*, 1.
[8] *Recent progress in the chemistry of 2-unsubstituted 1*H*-imidazole 3-oxides*, G. Mlostoń, M. Jasiński, A. Wróblewska, H. Heimgartner, *Curr. Org. Chem.* **2016**, doi:10.2174/1385272820666151210000010 [**H3**].

5.3.2. Brief discussion on goals and results

Alkoxyallene anions as relevant building blocks for the synthesis of polyfunctionalized *N*-, *O*- and *S*-heterocycles

A key goal of the research described in this summary is focused on the development of new synthetic strategies and their applications for the preparation of polyfunctionalized *O*-, *N*- and *S*-hetero(bi)cyclic systems including enantiomerically pure (or enriched) compounds as well as natural products analogues of potential biological activity. As suitable reaction partners towards title lithiated alkoxyallenes, chiral nitrones derived from carbohydrates have been selected. In addition, thiocarbonyl compounds (thioketones), and their oxo analogues have been tested as substrates. This research was initially performed during my post-doc stay in the group of professor H.-U. Reissig (Freie Universität Berlin, Germany) as a part of 'Kolumb' fellowship by Foundation for Polish Science, and subsequently continued at the home University in Łódź.

Based on earlier reports on the reactions of lithiated alkoxyallenes with both carbonyl compounds[3,9] and nitrones[10] as electrophiles, four types of nitrones **A**-**D** were selected as suitable substrates for further studies towards anions **1**:

- *(a)* *N*-glycosylhydroxylamines (**A**), as so-called 'masked nitrones', which exist in solutions in equilibrium with corresponding open-chain tautomers
- *(b)* *N*-benzyl-ω-*O*-sililated nitrones (**B**), typically derived from aldopentoses
- *(c)* nitrones of type **C** functionalized with removable carbohydrate-derived chiral auxiliary (Aux*) attached to the nitrogen atom
- *(d)* five-memebered, enantiomerically pure nitrones **D**

In addition, (cyclo)aliphatic thioketones **E** as well as its selected oxo analogues **F** (Fig. 4) have been selected for the study.

[9] *Stereoselective synthesis of 3(2*H*)-dihydrofuranones by addition of lithiated methoxyallene to chiral aldehydes*, S. Hormuth, H.-U. Reissig, *J. Org. Chem.* **1994**, *59*, 67.
[10] *Stereodivergent syntheses of highly substituted enantiopure 4-alkoxy-3,6-dihydro-2*H*-1,2-oxazines by addition of lithiated alkoxyallenes to carbohydrate-derived aldonitrones*, M. Helms, W. Schade, R. Pulz, T. Watanabe, A. Al-Harrasi, L. Fišera, I. Hlobilová, G. Zahn, H.-U. Reissig, *Eur. J. Org. Chem*. **2005**, 1003.

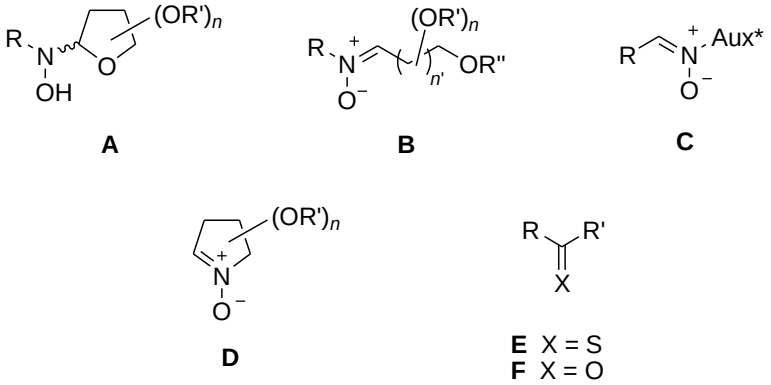


Fig. 4

Following structural features of starting nitrones **A**-**D** were emphesized:

(i) the presence of the stereodefined chirality center at the α-position with respect to azomethine group, which should result in highly diastereoselective addition of alkoxyallene anion

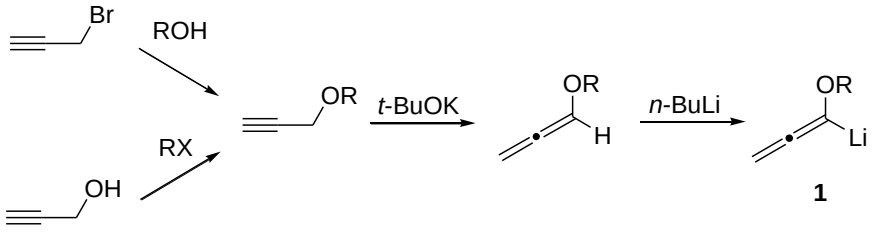
(ii) the presence of neighbouring OH-groups functionalized with appropriate protecting groups labile either under acidic or hydrogenation conditions

and in the case of **A**-**B** derivatives

(iii) the presence of terminal free hydroxy group (alternatively, OH protected with Brønsted-acid-labile function), which should allow further transformations on the enol-ether moiety of the target 1,2-oxazine

The title alkoxyallenes belong to readily accessible class of compounds, often isolated as a thermodynamic products of isomerization of the corresponding propargyl ethers, which are efficiently synthesized by standard Williamson protocol.[11] For example, alkylation of propargylic alcohol with dimethyl sulfate under basic conditions followed by isomerization in the presence of potassium *tert*-butoxide afford target methoxyallene (R = Me) in overall yield of 81% (Scheme 1).[12] Alternatively, propargyl bromide could be used as an electrophile towards the corresponding alkoxides. As it might be expected, the presence of the OR substituent significantly modifies reactivity of the allene unit. Thus, in the presence of a strong base such as organyllithium, alkoxyallene undergoes a selective α-deprotonation leading to corresponding anions **1**.

[11] *Äthinylierung*, W. Reppe *et al*., *Liebigs Ann. Chem.*, **1955**, *596*, 1.
[12] *Alkoxyallenes – building blocks in organic synthesis*, R. Zimmer, *Synthesis* **1993**, 165.



Scheme 1

Whereas lithiated methoxyallene (**1a**) has often been used as a model compound for initial studies, further syntheses were conducted with another precursors depicted in Figure 5. The presence of Bn and TMSE groups in **1b** and **1c** enable deprotection of hydroxyl group at the final steps either under catalytic hydrogenation conditions or by hydrolysis with suitable acid, respectively. In certain cases of prochiral reaction partners, enantiomerically pure lithiated DAG-allene **1d** functionalized with diacetonoglucose moiety was employed.

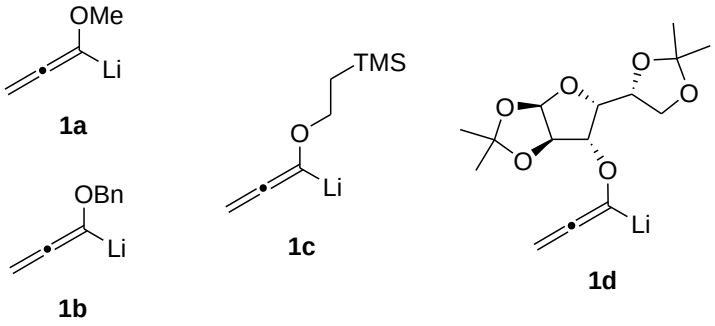
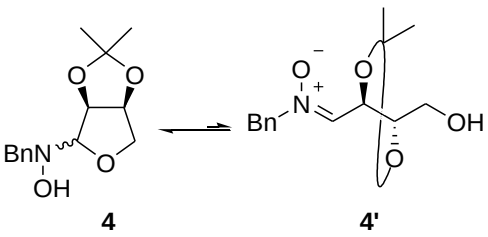


Fig. 5

In order to test the influence of the type of terminal groups in **A** and **B** on the reaction outcome in additions of lithiated alkoxyallenes **1** as well as on the subsequent Brønsted-acid-induced transformations (cyclisations), as a model compounds derived from L-erythrose: *N*-glycosylohydroxylamine **4**, equilibrating with open-chain nitrone **4'** (Scheme 2), and its structural analogue, sililated nitrone **5** (R ≠ H, Scheme 3) were selected.[13]

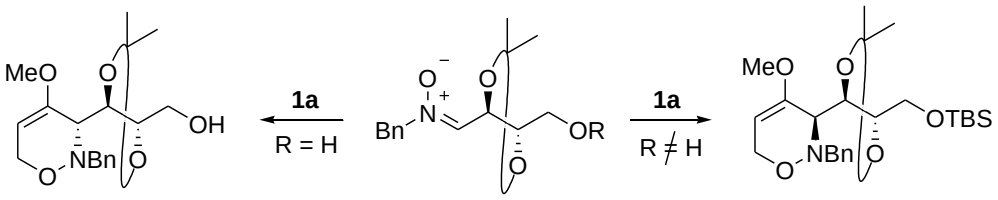


Scheme 2

As expected, reactions with lithiated alkoxyallenes performed under standard conditions (THF, –78 °C) provided desired 1,2-oxazine derivatives as products of formal [3+3]-cyclisation. However, the observed stereochemical outcome was different depending on the type of substituent located at the terminal position. Thus, *syn*- or *anti*-configured products were isolated (for R = [Si], Bn

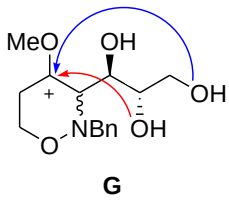
[13] a) *New synthesis of pyrrolidine homoazasugars via aminohomologation of furanoses and their use for the stereoselective synthesis of aza-C-disaccharides*, A. Dondoni, P. P. Giovannini, D. Perrone, *J. Org. Chem.* **2002**, *67*, 7203; b) *Synthesis of a branched chain aza-C-disaccharide via the cycloaddition of a chiral nitrone to an alkene, both sugar derivatives*, N. G. Argyropoulos, V. C. Sarli, *Tetrahedron Lett.* **2004**, *45*, 4237.

or R = H, respectively) in high yields and excellent diastereoselectivity (Scheme 3).[14] The observed switch of stereochemical outcome was explained based on the classical Felkin-Anh model. In the case of the 'masked nitrone' **4'** (R = H) the formation of the eight-membered ring by intramolecular coordination of lithium cation of the *in situ* generated alkoxide to the nitrone O-atom is assumed. As a result, the electrophilic center of the azomethine group is shielded at the *Si*-face, and the subsequent attack of the allene anion takes place from the unhindered *Re*-face leading to *anti*-configured product.



anti-**6** (91%, dr 96:4) — **4'**, **5** — *syn*-**6** (85%, dr 90:10)

Scheme 3

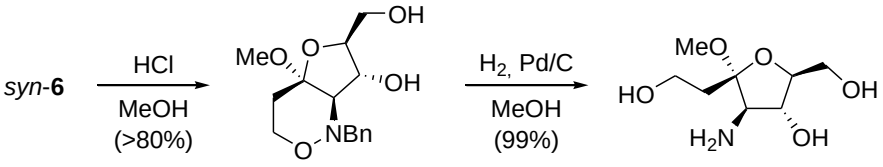


G

Fig. 6

Having in hands diastereomeric 3,6-dihydro-2*H*-1,2-oxazines, in the next step, the influence of the absolute configuration of the starting oxazine derivative on the cyclisation outcome was investigated. Under acidic conditions (*e.g.* in the presence of HCl in methanol as a Brønsted acid), compound of type **6** should undergo simultaneous deprotection (hydrolysis) of the acetonide/silyl groups and the protonation at the enol-ether moiety leading to the carbocation of type **G** (Fig. 6). Depending on the steric hindrance in the starting compound, these intermediates should subsequently undergo cyclisation into bicyclic furan and/or pyran derivatives.

As a matter of fact, in the case of *syn*-configured series, the reaction smoothly provided furanoids of type **7** formed in a highly *regio*- and *cis*-stereoselective fashion. As depicted in Scheme 4, subsequent simultaneous debenzylation and ring opening in the bicyclic oxazine **7** performed under standard reaction conditions (catalytic hydrogenation with H_2, Pd/C) provided enantiopure, polyfunctionalized 3-aminofuranoside derivative **8** almost quantitatively.



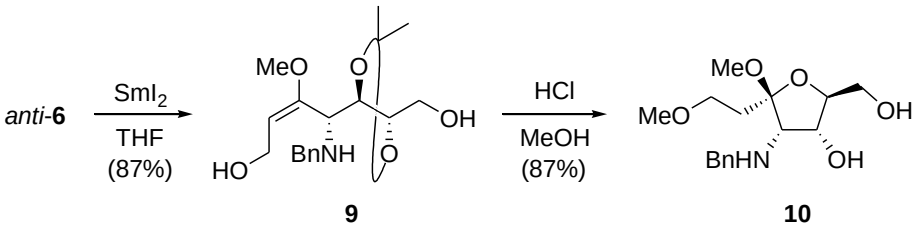
7 **8**

Scheme 4

[14] *Application of L-erythrose-derived nitrones in the synthesis of polyhydroxylated compounds via 3,6-dihydro-2*H*-1,2-oxazine derivatives*, M. Jasiński, D. Lentz, E. Moreno-Clavijo, H.-U. Reissig, *Eur. J. Org. Chem.* **2012**, 3304 [**H9**].

When analogous cyclisation protocol was applied for *anti*-configured 1,2-oxazine derivatives, the corresponding products were isolated. However, the formation of a mixture of diastereomeric bicyclic products of furo- and pyrano- series was also observed. Again, the tendency for *cis*-cyclisation was an important factor. The structure of the isolated compounds, including absolute configurations at the newly generated chirality centres, was determined based on spectroscopic methods supplemented by X-ray analysis. As demonstrated in additional experiments, favored 1,5-cyclisation over the 1,6-ring closure clearly correspond to the relative reaction rates of the irreversible competitive cyclisation *vs.* acetonide deprotection processes. Thereby, no interconversion of the bicyclic furan and pyrane derivatives formed as thermodynamic products takes place under the applied reaction conditions. It should also be emphasized, that the extraordinary mild conditions of the elaborated protocol aimed at the preparation of polyfunctionalized heterocycles, require the most simple chemical reagents such as hydrochloric acid (HCl) and hydrogen (H_2, Pd/C)!

In addition to previous results, it was demonstrated that the target aminosugars could also be prepared from the starting 1,2-oxazines by analogous reaction steps performed in the opposite order (reductive ring-opening in the first step followed by cyclisation of the respective allylic alcohol). The best results for the reduction of the N–O bond were noticed in the case of samarium(II) diiodide demonstrated as a highly chemoselective single-electron-transfer (SET) agent often used in heteroatom-heteroatom cleavage reactions.[15] Again, the favored formation of the five membered ring was observed in the cyclisation step (Scheme 5). However, compound **10** bearing additional methoxy group located at the β carbon atom of the pendant chain was unexpectedly isolated as the major product.



Scheme 5

Very likely, under the applied reaction conditions, starting allylic alcohol **9** undergoes deprotection (acetonide group) followed by cyclisation and subsequent elimination of methanol leading to a Michael acceptor species existing as the oxocarbenium ion **H** (Fig 7). Subsequently, this intermediate undergoes addition of two MeOH equivalents to afford product **10**. The absolute configuration at the newly generated stereogenic center at C(2) was confirmed on the basis of spectroscopic methods (NOESY).

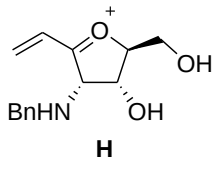
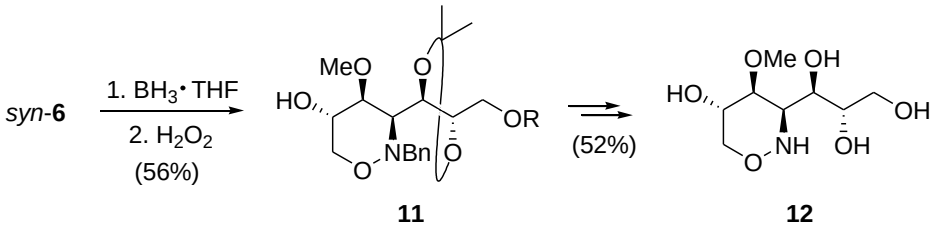


Fig. 7

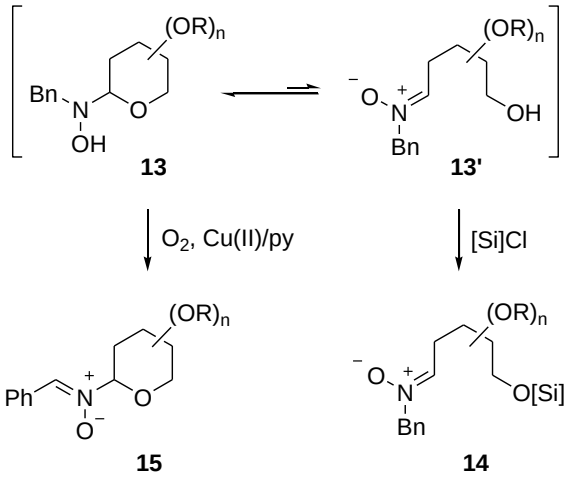
[15] a) *Organic synthesis using samarium diiodide, a practical guide*, D. J. Procter, R. A. Flowers II, T. Skrydrup, Royal Society of Chemistry Publishing, Cambridge, UK, 2010; b) *Cleavage of N−O bonds promoted by samarium diiodide: Reduction of free or N-acylated O-alkylhydroxylamines*, J. L. Chiara, C. Destabel, P. Gallego, J. Marco-Contelles, *J. Org. Chem.* **1996**, *61*, 359; c) *Samarium(II) iodide reduction of isoxazolidines*, J. Revuelta, S. Cicchi, A. Brandi, *Tetrahedron Lett.* **2004**, *45*, 8375.

With new enantiopure 1,2-oxazines in hand, other polyhydroxylated heterocycles depicted in Scheme 6 could be efficiently prepared. For example, hydroboration of *syn*-**6** under standard reaction conditions, using BH_3•THF followed by oxidative work-up (H_2O_2/NaOH), provided alcohol **11** in a highly stereoselective manner. After exhaustive deprotection of **11** by *N*-debenzylation under catalytic hydrogenation, followed by acidic hydrolysis performed using ion exchange resin DOWEX-50, the corresponding aza-sugar derivative **12** was isolated in high overall yield of 29%.



Scheme 6

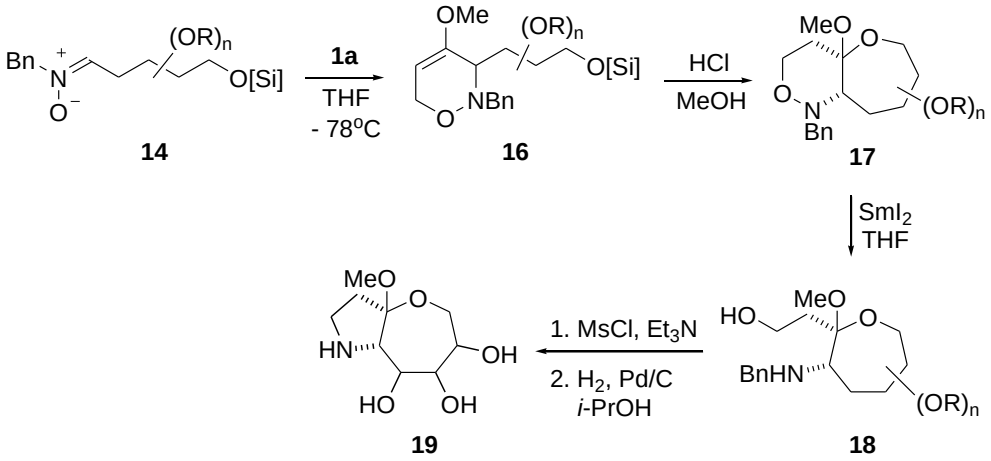
The general importance of the discussed protocol for the preparation of *O*-heterocycles by Brønsted-acid induced cyclisation was confirmed in another work aimed at the synthesis of biologically important polyfunctionalized oxepane derivatives. In that case, the synthesis of starting δ-silylated nitrones of type **14** *via* direct silylation of the corresponding *N*-substituted hydroxylamines **13**/**13'**, including tetrahydropiran derivative and three perbenzylated aldopyranoses (of L-arabinose, D-ribose, and D-xylose series), was developed (Scheme 7).[16] In addition, it was demonstrated that starting materials **13** in the presence of Cu^{II}/pyridine complex undergo highly chemo- and stereoselective aerial oxidation at the benzyl group leading to nitrones **15** functionalized with carbohydrate-derived chiral auxiliary. The latter, readily available compounds **15**, are considered as attractive building blocks for stereocontrolled synthesis.[17]



Scheme 7

[16] *Synthesis of aldopentapyranose-derived nitrones by silylation or Cu(II)-catalyzed aerobic oxidation of N-glycosylhydroxylamines*, J. Maciaszczyk, M. Jasiński, *Tetrahedron: Asymmetry* **2015**, *26*, 510-515 [**H4**].
[17] *Key chiral auxiliary applications*, Ed. G. Roos, Academic Press, Oxford 2014.

The resulting sililated *Z*-aldonitrones **14** were reacted with model lithiated methoxyallene to afford a series of expected 3,6-dihydro-2*H*-1,2-oxazine derivatives **16**. As anticipated, compounds **16** in the presence of Brønsted-acid underwent deprotection at the terminal OH group followed by 1,7-ring closure leading to (*cis*)-bicyclic oxepanoides **17** (Scheme 8).[18] As a result of subsequent reduction of the relatively weak N–O bond, a series of target septanoside derivatives **18** was prepared in good yields of ~30% (after three steps). Furthermore, the presence of the pendant hydroxyethyl group neighbouring secondary amine moiety opened further opportunities in the synthesis of fused septanosides. Thus, activation of the former group by treatment with methanesulfonyl chloride (MsCl) resulted in a spontaneous cyclisation into oxepino[3,2-*b*]pyrrolidines, which after exhaustive deprotection of the OH groups provided new class of pyrrolidinoseptanosides of type **19**.

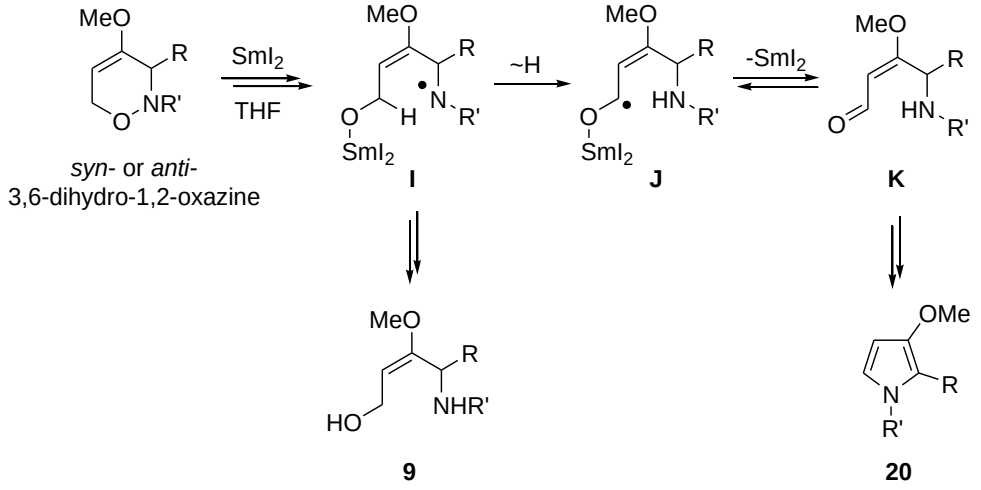


Schemat 8

As already mentioned, after pioneer work by Kagan and co-workers[19] samarium(II) diiodide (SmI_2) become one of the most important modern chemoselective reducing agents often used in the preparation of more complex systems by dehalogenation, deoxygenation, debenzylation, and in the first line – by the formation of a new C-C bonds.[20] It is evidenced, that reductive ring opening of the dihydro-1,2-oxazine skeleton leads to corresponding allylic amino alcohols of type **9** (Scheme 5, Scheme 9), which are considered as useful starting materials *e.g.* for the synthesis of *N*-, and *O*-heterocycles. For that reason, a series of selected 3,6-dihydro-2*H*-1,2-oxazines was tested in the reactions with SmI_2, prepared as a THF solution by treatment of samarium metal with elemental iodine.[21] Unexpectedly, in certain cases the competitive formation of pyrrole derivatives **20** as a minor product was observed (Scheme 9). In order to gain more information about unexpected formation of

[18] *Three-step synthesis of 3-aminoseptanoside derivatives by using lithiated methoxyallene and δ-siloxynitrones*, M. Jasiński, G. Utecht, A. Fruziński, H.-U. Reissig, *Synthesis* **2016**, *48*, 893 [**H1**].
[19] *Divalent lanthanide derivatives in organic synthesis. 1. Mild preparation of SmI_2 and YbI_2 and their use as reducing or coupling agents*, P. Girard, J. L. Namy, H. B. Kagan, *J. Am. Chem. Soc.* **1980**, *102*, 2693.
[20] a) *Samarium(II)-iodide-mediated cyclizations in natural product synthesis*, D. J. Edmonds, D. Johnston, D. J. Procter, *Chem. Rev.* **2004**, *104*, 3371; b) *Samarium diiodide induced ketyl-(het)arene cyclisations towards novel N-heterocycles*, C. Beemelmanns, H.-U. Reissig, *Chem. Soc. Rev.* **2011**, *40*, 2199.
[21] *The reaction of samarium(III) iodide with samarium metal in tetrahydrofuran. A new method for the preparation of samarium(II) iodide*, T. Imamoto, M. Ono, *Chem. Lett.* **1987**, 501.

20, the title reaction was studied in detail. Hence, the influence of the stoichiometry of the substrates, reaction times, temperature, influence of acid and Lewis base, as well as the configuration (*syn*-/*anti*-) of the oxazine precursor on the reaction outcome have been analyzed.[22] Based on experimental results it is postulated, that the key intermediate **I** undergoes an intramolecular H-shift as a crucial step leading to ketyl radical **J**, which exist in equilibrium with the corresponding carbonyl compound and, hence, deliver α,β-unsaturated amine aldehyde **K.** The latter is considered as the precursor of the observed pyrrole derivative **20** formed *via* favourable 5-*egzo-trig* ring-closure (followed by elimination of H_2O).

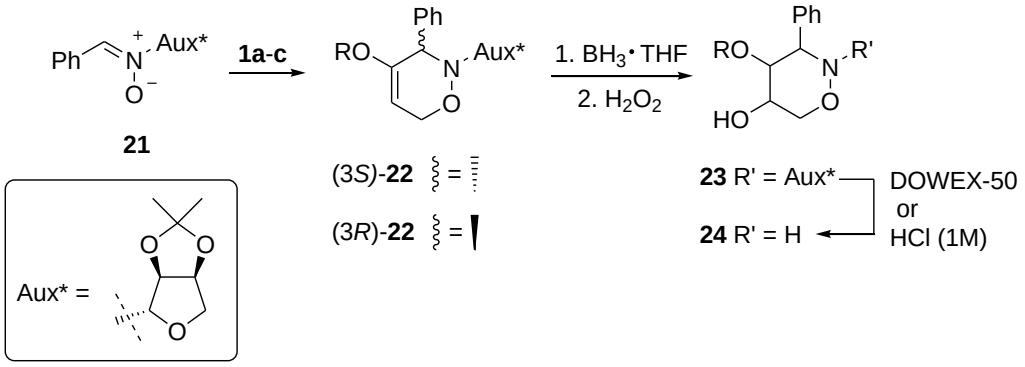


Scheme 9

One of the modern strategies aimed at preparation of optically active compounds in an industrial scale requires the use of so-called chiral auxiliaries, which are the moieties temporarily incorporated into the substrate in order to induce the control of stereochemical outcome of the transformations. As a subclass of these moieties, carbohydrate-derived[23] residues are of special importance, mainly due to a unique reactivity of the anomeric center, that enables final deprotection under smooth reaction conditions and reuse of the chiral auxiliary in further syntheses. This approach was also applied for the studies with lithiated alkoxyallenes, and the model nitrone **21** bearing L-erythrose-derived moiety at the nitrogen atom offer a representative example (Scheme 10).[24] As a result of carbophilic addition of anions **1a-c** onto **21**, the expected 1,2-oxazines **22** were prepared in good yields (up to 75%) under optimized reaction conditions (–130 → –80 °C, THF), and subsequently isolated as a mixture of diastereoisomers (typically in a ratio of 2:1). The moderate

[22] *Samarium diiodide promoted reduction of 3,6-dihydro-2H-1,2-oxazines: Competition of 1,4-amino alcohol formation and ring contraction to pyrrole derivatives*, M. Jasiński, T. Watanabe, H.-U. Reissig, *Eur. J. Org. Chem.* **2013**, 605 [**H7**].
[23] a) Z. Miao, K. Totani, K.-i. Tadano, N. Khiar, I. Fernández, A. Alcudia, M. V. García, R. Recio, M. M. K Boysen, *Carbohydrate auxiliaries* w *Carbohydrates – tools for stereoselective synthesis* (Ed. M. M. K. Boysen), Wiley-VCH, Weinheim 2013, pp.1-124; b) N. Pleuss, G. Zech, B. Furman, H. Kunz, *Sugars as chiral auxiliaries* w *The organic chemistry of sugars* (Eds.D. E. Levy, P, Fügedi), CRC Press, Boca Raton 2005, pp. 427-481.
[24] *Carbohydrate-auxiliary assisted preparation of enantiopure 1,2-oxazine derivatives and aminopolyols*, M. Jasiński, D. Lentz, H.-U. Reissig, *Beilstein J. Org. Chem.* **2012**, *8*, 662 [**H8**].

stereoselectivity of the studied reaction was explained by the competitive influence of electronic and steric effects (Fig. 8).



Scheme 10

In the case of allenes bearing relatively small substituents *e.g.* methoxyallene (**1a**) or TMSE-allene (**1c**), due to favored *syn*-attack supported by so-called 'kinetic anomeric effect',[25] stabilizing the respective transition state, corresponding 3*S*-configured 1,2-oxazines **22** (dr ≈ 2:1) were isolated as major products. On the other hand, more sterically hindered benzyloxyallene anion (**1b**) favored the *anti*-attack leading to 3*R*-configured 1,2-oxazine of type **22**, and the product was isolated as a mixture in an opposite ratio of the diastereoisomers (dr ≈ 1:2) (Scheme 10). Readily available in multigram scale products **22** were separated by standard chromagraphy techniques, and the optically pure samples were subsequently hydroxylated to afford alcohols **23**. Whereas in the case of 3*R*-series relatively high diastereomeric excess was observed (*cis-trans/trans-trans* ratio ≈ 8:2), the 3*S*-configured 1,2-oxazines provided mixture of the respective alcohols in dr ≈ 3:2, only. The observed significant difference in diastereomeric excess of the hydroboration of the C=C bond of the enol-ether moiety results, very likely, from steric reasons caused by neighbouring Ph group. As supplemented by the X-ray analysis, in the case of 3*R*-configured substrates, the latter occupies pseudoaxial position (Ψ^a) in a half-chair conformation of the starting 3,6-dihydro-1,2-oxazine (Fig. 9), whereas in the case of 3*S*-series, the Ph group is located very likely in pseudoequatorial position resulting in the less effective shielding of the double bond; thus, in the case of 3*S*-configured substrates the electrophile can effectively attack both sides of the double bond.

[25] *The kinetic anomeric effect. Additions of nucleophiles and of dipolarophiles to N-glycosylnitrones and to N-pseudoglycosylnitrones*, R. Huber, A. Vasella, *Tetrahedron* **1990**, *46*, 33.

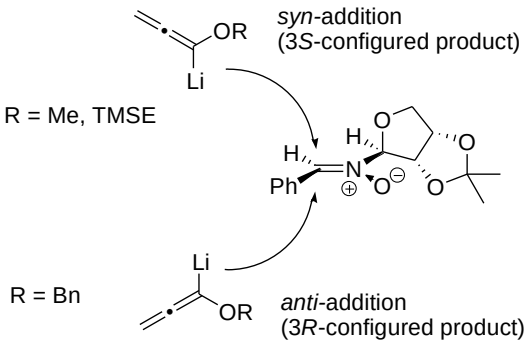


Fig. 8

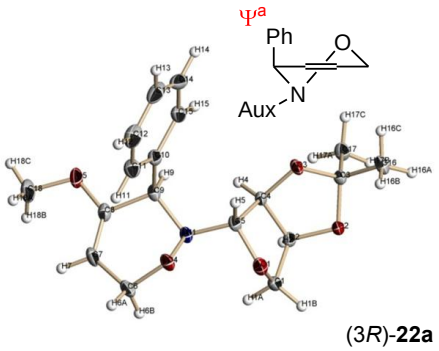
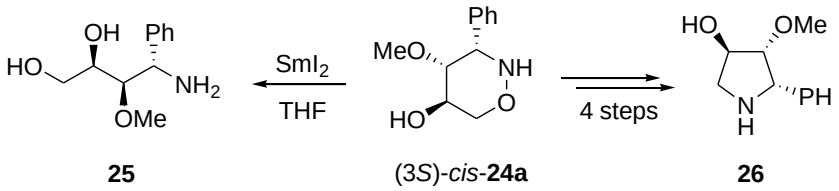


Fig. 9

The target *N*-unsubstituted tetrahydro-1,2-oxazine derivatives **24** were prepared in high yields from **23** by removal of chiral auxiliary under acidic conditions (ion exchange resin DOWEX or HCl in methanol, Scheme 10). It is worthmentioning, that TMSE-derived substrates (**c** series) also suffer simultaneous deprotection of the hydroxyl group located at C(4) (R = H) under the applied reaction conditions, wheres analogous deprotection for methoxyallene series (**a**) was successfully achieved by standard methyl-ether cleavage protocol using BBr_3. Two selected possible applications of the final 1,2-oxazine derivatives **24** lacking substituent at the N(1) are depicted in Scheme 11. For example, reductive N–O cleavage provided corresponding amino polyols of type **25** in excellent yield of >94%. On the other hand, the alternative transformations (4 step reaction sequence, including re-cyclisation of the respective amino alcohol) provided enantiomerically pure pyrrolidine derivative **26**.[24]



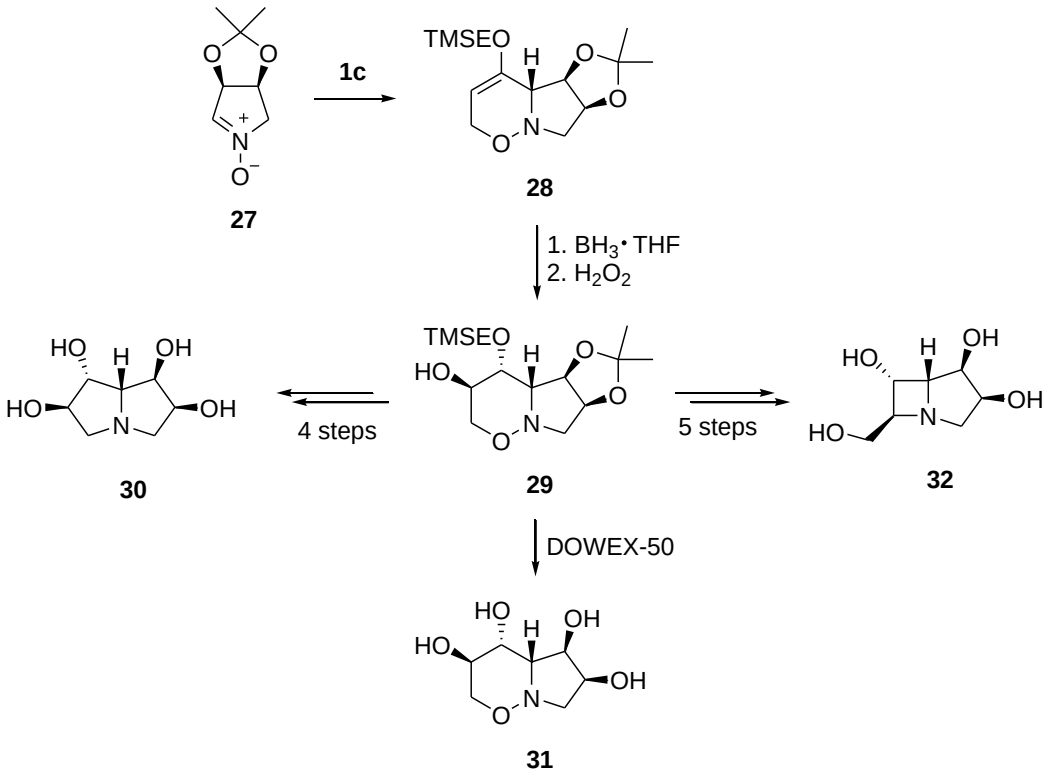
25 (3*S*)-*cis*-**24a** **26**

Scheme 11

As demonstrated in another work, [3+3]-cyclisation of the alkoxyallene anions **1** with cyclic nitrones of type **D** open up an easy access to fused 1,2-oxazine derivatives, as a highly versatile building blocks for the preparation of polyhydroxylated azabicyclic systems such as pyrrolizidines and a new class of fused azetidine derivatives, structurally analogous to well known β-lactam antibiotics (carbapenams). For example, in the reaction of lithiated TMSE-allene (**1c**) with enantiomerically pure nitrone **27**, the expected bicyclic product **28** (72%) was isolated, which after initial highly diastereoselective hydroxylation (compound **29**) was applied for the preparation of the target heterocycles depicted in Scheme 12.[26] Thus, depending on the type and the order of further transformations (which consisted of protection/deprotection of the functional groups, reductive ring opening and re-cyclisation processes) corresponding pyrrolizidine **30** (a known amyloglycosidase

[26] *Synthesis of a series of enantiopure polyhydroxylated bicyclic N-heterocycles from an L-erythrose derived nitrone and alkoxyallenes*, M. Jasiński, E. Moreno-Clavijo, H.-U. Reissig, *Eur. J. Org. Chem.* **2014**, 442 [**H6**].

inhibitor of fungi of *Rhizopus* species),[27] bicyclic tetrahydro-1,2-oxazine **31** (formally, structural analogue of 5-oxa-indolizidine) and polyhydroxylated azabicyclo[3.2.0]heptane derivative **32** were prepared in 39%, 98%, and 27% yields, respectively.



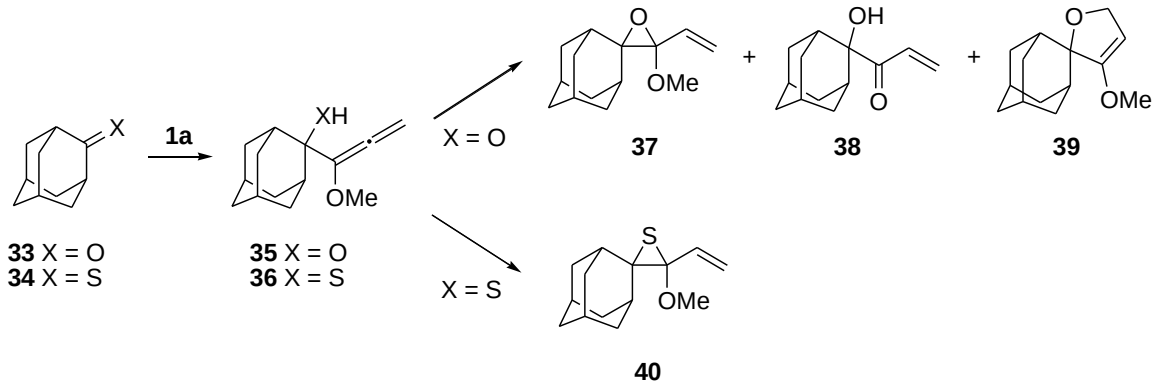
Scheme 12

Based on the presented general protocol, an analogous approach was applied by Reissig and co-workers for the total synthesis of australine and casuarine, naturally occurring iminosugars (pyrrolizidines) of biological importance.[28] More recently, similar procedure was adapted for studies using achiral 2,3,4,5-tetrahydropyridine oxide as a substrate to give racemic 8a-*epi*-lentiginosine as a first example of indolizidine derivative prepared by the discussed methodology.[29]

As already mentioned in the introduction, additions of lithiated alkoxyallenes **1** onto carbonyl compounds and their derivatives lead to corresponding allenyl intermediates, which typically undergo further spontaneous transformations. According to previously reported results on reactions of aldehydes and ketones with anions **1**, the initially formed allenyl alcohols tend to undergo cyclisation into 1,5-fashion to afford 3-alkoxy-2,5-dihydrofuran derivatives,[3,9,30] whereas in certain cases of

[27] *Stereoselective synthesis of novel tetrahydroxypyrrolizidines*, A. T. Carmona, J. Fuentes, P. Vogel, I. Robina, *Tetrahedron: Asymmetry* **2004**, *15*, 323.
[28] *Stereocomplementary routes to hydroxylated nitrogen heterocycles: Total syntheses of casuarine, australine, and 7-epi-australine*, C. Parmeggiani, F. Cardona, L. Giusti, H.-U. Reissig, A. Goti, *Chem.–Eur. J.* **2013**, *19*, 10595.
[29] *Wykorzystanie anionu alkoksyallenowego w syntezie pochodnych indolizydyny*, B. Busiak, *Praca magisterska*, Uniwersytet Łódzki 2015 (promotor: M. Jasiński); *publikacja w przygotowaniu*.
[30] *3-Alkoxy-2,5-dihydrofurans by gold-catalyzed allenyl cyclizations and their transformation into 1,4-dicarbonyl compounds, cyclopentenones, and butenolides*, M. Brasholz, B. Dugovič, H.-U. Reissig, *Synthesis* **2010**, 3855.

sterically demanding precursor ketones the alternative cyclisation-1,3 leading to oxirane derivatives was observed.[31] Analogously, thiocarbonyl compounds should serve as attractive substrates for the synthesis of sulfur-containing heterocycles. In order to compare the reactivity of lithiated methoxyallene (**1a**) with thioketones and their oxo analogues, admantanone (**33**) and adamantanethione (**34**) were selected for initial studies (Scheme 13). Whereas the reaction of **1a** with ketone **33** provided fairly stable adduct **35** (95%), which depending on the reaction conditions underwent competitive 1,3-, 1,5-cyclisation, and also hydrolysis as a minor process, in the case of adamantanethione (**34**) corresponding methoxy-vinylthiirane derivative **40** (79%) was isolated as a sole product.[32]



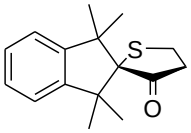
Scheme 13

The exclusive carbophilic attack of the anion **1a** onto **34** was confirmed in additional experiments in which MeI and D_2O, respectively, were used in order to trap the transient thiolate intermediate. In these experiments carried out under standard reaction conditions corresponding methyl sulfide (89%) and the d_1-labelled vinylthiirane **40**-d_1 (71%) were isolated as major components, respectively. As expected, the NMR analysis confirmed the location of deuterium at C-1' of the vinyl moiety. Based on these observations it is postulated, that in contrast to hydroxyallenyl derivatives of type **35**, the respective allenylthiol analogues (**36**) undergo spontaneous 1,3-cyclisation, very likely facilitated by the enhanced acidity of the SH group.

In the case of the reactions with prochiral substrates such as tiofenchon or the Cookson's 'cage thione' the carbophilic addition of **1a** onto the C=S bond took place only from the less hindered *egzo*-face of the polycyclic scaffold, however, due to unhindered rotation of the allenyl substituent in the initially formed products of type **36**, the formation of the isomeric *cis*- and *trans*-vinylthiiranes was observed.

[31] *Mechanistic and synthetic aspects of intramolecular alkoxide-allene cyclizations*, P. Magnus, P. Albaugh-Robertson, *J. Chem. Soc. Chem. Commun.* **1984**, 804.
[32] *Reactions of cycloaliphatic thioketones and their oxo analogues with lithiated methoxyallene: A new approach to vinylthiiranes*, M. Jasiński, G. Mlostoń, M. Stolarski, W. Costa, M. Domínguez, H.-U. Reissig, *Chem. Asian J.* **2014**, *9*, 2641 [**H5**].

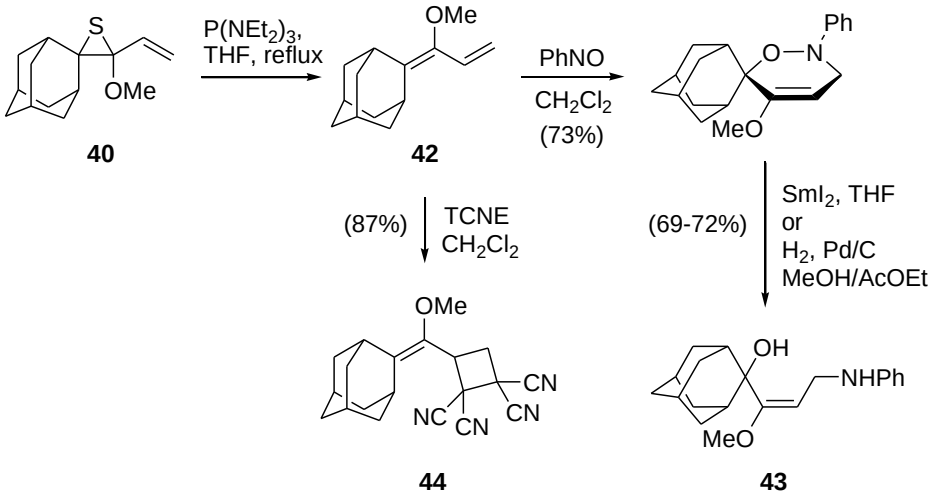
It should be emphasized, that in the case of sterically more hindered starting materials bearing an additional group at the α position, next to the thiocarbonyl moiety, the alternative 1,5-cyclisation pathway was noticed. Hence, the sterically hindered tetramethyl-indanthione provided tetrahydrothiophen-3-one **41** (73%) as the major product formed by the hydrolysis of the enol-ether group of the initially formed 2,5-dihydrothiophene derivative (Fig. 10).



41

Fig. 10

As an exemplary application of the new class of vinylthiiranes the desulfurization reaction leading to hitherto unknown electron-rich diene **42** functionalized with highly oleophilic (polycyclic) scaffolds should be mentioned. Such compounds are considered as potentially attractive substrates for the Diels-Alder chemistry. In the light of the fact that numerous adamantane derivatives exhibit biological activity,[33] particular attention was paid to the diene **42**, which was tested towards selected reactive dienophiles. Surprisingly, due to remarkable steric hindrance caused by the adamantane unit the formation of desired cycloadducts was observed only in certain cases of relatively small, electron-deficient reaction partners. For example, in the reaction of **42** with nitrozobenzene the corresponding 1,2-oxazine derivative was obtained as the target [4+2]-cycloadduct, which was smoothly converted into the respective amino alcohol **43** by treatment with SmI_2/THF. In contrast, in the reaction with sterically more demanding tetracyanoethylene (TCNE) the respective cyclobutane derivative **44** was isolated as the major product formed *via* a thermal, step-wise (diradical) [2+2]-cycloaddition (Scheme 14).[34]



Scheme 14

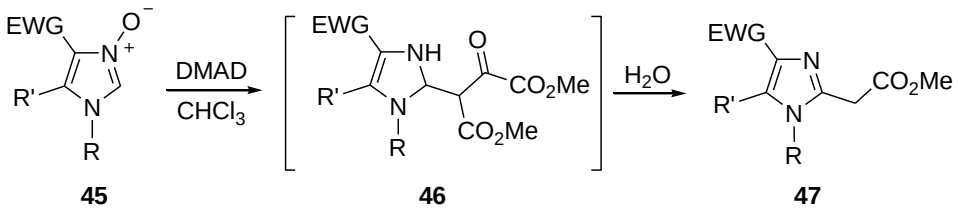
[33] *The lipophilic bullet hits the targets: Medicinal chemistry of adamantane derivatives*, L. Wanka, K. Iqbal, P. R. Schreiner, *Chem. Rev.* **2013**, *113*, 3516.
[34] a) *Competing cyclobutane formation and Diels-Alder reaction*, C. A. Stewart, Jr., *J. Am. Chem. Soc.* **1962**, *84*, 117; b) *1,4- and 3,4-Cycloaddition reactions of 1,1-diphenyl-l,3-butadiene with tetracyanoethylene*, J. J. Eisch, G. R. Husk, *J. Org. Chem.* **1966**, *31*, 589.

2-Unsubstituted imidazole 3-oxides as 1,3-dipoles in the synthesis of (poly)functionalized mono- and bicyclic imidazole derivatives

As mentioned in the introduction, another topic of the submitted Thesis covers the synthesis and novel transformations of 2-unsubstituted imidazole 3-oxides of type **3**, as a class of azaaromatic nitrones of unusuall reactivity displayed towards dipolarophiles and nucleophilic agents. The primary limitation in the use of *N*-oxides **3** in the reactions with some more reactive nucleophiles, particularly with metallorganyls (*e.g.* lithiated alkoxyallenes), results from low solubility of nitrones **3** in standard etheral solvents (Et_2O, THF) often used for the water-free transformations. More importantly, most of the known imidazole 3-oxides **3** exist in the form of hydrates, and contain variable amounts of water stabilizing the *N*-oxide group. For that reason, the main applications of **3** comprise the reactions with no moisture-sensitive dipolarophiles. In this context, the presented results are focused on derivatives of type **3** functionalized with electon-withdrawing groups (EWG) located at the C(4) of the imidazole ring. As demonstrated experimentally, the presence of EWG substituents remarkably influences the reactivity of the azomethine group, and openes new opportunities in the synthesis of imidazole-based systems.

One of the most often applied method for the synthesis of 2-unsubstituted imidazole 3-oxides comprises condensation of α-hydroxyimino ketones and hexahydro-1,3,5-triazines, which in the solution exist in equilibrium with the respective monomeric form (formaldimine).[35] According to previous results by Mlostoń's group, reactions of aryl-alkyl substituted nitrones of type **3** with dimethyl acetylenedicarboxylate (DMAD) furnish corresponding 2-oxo-butanoates formed *via* the initial [3+2]-cycloaddition followed by re-aromatization of the imidazole ring.[36] As a part of this Thesis, a series of imidazole 3-oxides **45** bearing ester, amide, and carbonyl groups was reacted with DMAD to give unexpectedly different products identified as (imidazol-2-yl)acetates **47**.[37] As depicted in Scheme 15, nitrones **45** undergo analogous addition onto DMAD, however, due to strong electron withdrawing effect by substituents located at C(4), the initially formed derivatives of type **46** suffer spontaneous retro-aldol reaction (known as an *oxaloyl cleavage*) to give (imidazol-2-yl)acetate derivatives. Moreover, it was demonstrated, that succinates **46** derived from unactivated imidazole 3-oxides could also be transformed into the respective acetates of type **47** under base-mediated reaction conditions.

[35] *Studies in azole chemistry. Part I. Synthesis and reactions of some imidazole 3-oxides*, I. J. Ferguson, K. Schofield, *J. Chem. Soc. Perkin Trans. 1*, **1975**, 275.
[36] *Reactions of 2-unsubstituted 1*H*-imidazole 3-oxides with heterocumulenes and dimethyl acetylenedicarboxylate*, G. Mlostoń, T. Gendek, H. Heimgartner, *Tetrahedron* **2000**, *56*, 5405.
[37] *Straightforward access to (imidazol-2-yl)acetates by reaction of 2-unsubstituted imidazole 3-oxides with dimethyl acetylenedicarboxylate*, G. Mlostoń, M. Jasiński, H. Heimgartner, *Eur. J. Org. Chem.* **2011**, 2542 [**H12**].



45 **46** **47**

Scheme 15

Due to limited stability of (imidazol-2-yl)acetic acids, which typically undergo spontaneous decarboxylation, the presented new approach to their ester analogues by the reaction of **45** with DMAD offer an attractive alternative pathway for the synthesis of these highly useful building blocks considered as key substrates, *e.g.* in the preparation of imidazole-containing compounds of biological interest.[38]

As an another important achievement of this Thesis, the development of the general protocol towards enantiopure, hemisalen-like imidazole 3-oxides **48** derived from (*R*,*R*)-*trans*-diamino-cyclohexane ((*R*,*R*)-DACH) should be indicated (Scheme 16).[39] Keeping in mind well documented (organo)catalytic activity of bis-imidazole 3-oxides (*e.g.* used as an Lewis bases for the asymmetric allylation of aldehydes, and also for asymmetric cyclopropanations)[40] as well as the high utility of thiourea-contaning compounds in stereocontrolled syntheses, some attention has been paid to the 'sulfur transfer reaction'[41] with **48** leading to imidazole-2-thiones of type **50**. Again, different behavior of the EWG-functionalized imidazole 3-oxides in the step-wise [3+2]-cycloaddition reactions with dithione **49** could be observed. In the reaction mixture, side by side with the expected imidazole-2-thione **50**, the deoxygenated imidazole derivative **51** was found as the alternative product. This non-concerted type of the [3+2]-reaction observed for series of model EWG-functionalized imidazole 3-oxides was discussed in great detail in another work.[42]

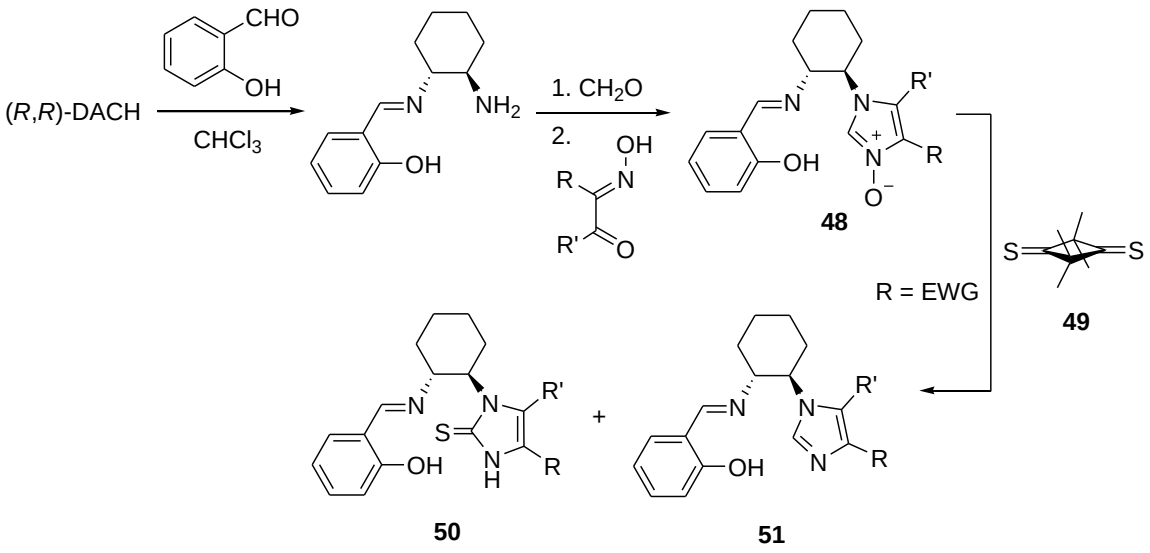
[38] a) *Some benzyl-substituted imidazoles, triazoles, tetrazoles, pyridinethiones, and structural relatives as multisubstrate inhibitors of dopamine β-hydroxylase. 4. Structure-activity relationships at the copper binding site*, L. I. Kruse, C. Kaiser, W. E. DeWolf, J. A. Finkelstein, J. S. Frazee, E. L. Hilbert, S. T. Ross, K. E. Flaim, J. L. Sawyer, *J. Med. Chem.* **1990**, *33*, 781; b) *Tricyclic pyridones as functionally selective human $GABA_A\alpha_{2/3}$ receptor-ion channel ligands*, J. Crawforth, J. R. Atack, S. M. Cook, K. R. Gibson, A. Nadin, A. P. Owens, A. Pike, M. Rowley, A. J. Smith, B. Sohal, F. Sternfeld, K. Wafford, L. J. Street, *Bioorg. Med. Chem. Lett.* **2004**, *14*, 1679; c) *A one-pot synthesis of polysubstituted imidazo[1,2-*a*]pyridines*, A. S. Kiselyov, *Tetrahedron Lett.* **2006**, *47*, 2941.

[39] *Optically active imidazoles derived from enantiomerically pure* trans*-1,2-diaminocyclohexane*, G. Mlostoń, D. Rygielska, M. Jasiński, H. Heimgartner, *Tetrahedron: Asymmetry* **2011**, *22*, 669 [**H10**].

[40] *Novel chiral* C_2*-symmetric bisimidazole-*N*-oxides as promising organocatalysts for enantioselective allylation of aromatic aldehydes*, P. Kwiatkowski, P. Mucha, G. Mlostoń, J. Jurczak, *Synlett* **2009**, *11*, 1757; b) *Chiral imidazoles and imidazole* N*-oxides as ligands for stereoselective cyclopropanation reactions*, G. Mlostoń, P. Mucha, H. Heimgartner, *Lett. Org. Chem.* **2012**, *9*, 89.

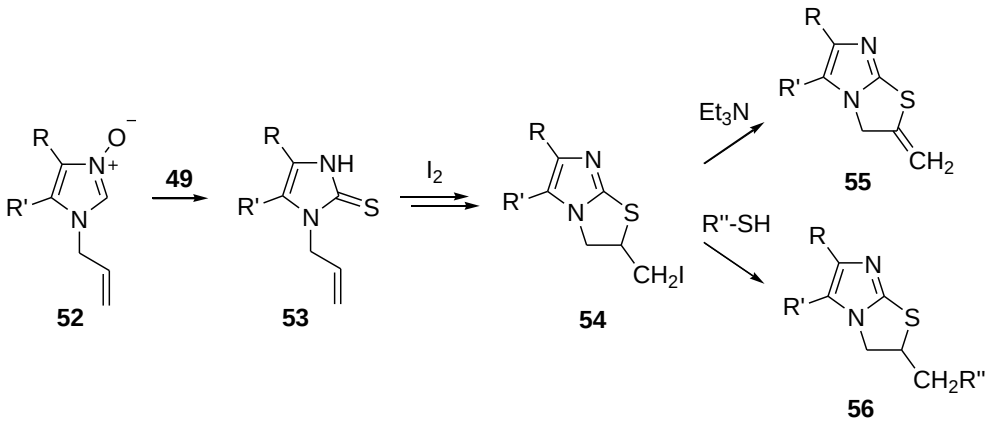
[41] *First examples of reactions of azole* N*-oxides with thioketones: A novel type of sulfur-transfer reaction*, G. Mlostoń, T. Gendek, H. Heimgartner, *Helv. Chim. Acta*, **1998**, *81*, 1585.

[42] *Synthesis of new imidazole 3-oxides: Unexpected deoxygenation of some derivatives in the reaction with 2,2,4,4-tetramethylcyclobutane-1,3-dithione*, G. Mlostoń, M.; Jasiński, D. Rygielska, H. Heimgartner, *Heterocycles* **2011**, *83*, 765 [**H11**].



Scheme 16

Another, new application of 2-unsubstituted imidazole 3-oxides was demonstrated by using *N*-allyl derivatives, which served as easily available substrates for the preparation of bicyclic systems. After conversion of the starting *N*-allyl imidazole 3-oxides of type **52** into the respective imidazole-2-thiones **53** (52-89%), the iodine-mediated radical 5-*egzo*-*trig*-cyclisation allowed the preparation of a series of 2,3-dihydro-imidazo[2,1-*b*]thiazole derivatives **54** in fair to good yields (Scheme 17).[43] The presence of the new reaction center (iodomethyl group) in **54** was exploited for subsequent transformations with relatively weak base (Et_3N) and *S*-nucleophiles leading in the first case to the corresponding egzomethylene derivatives **55**, and in the second case to bicyclic products **56**. In the case of other less nucleophilic agents such as cyanide anion, high tendency of compounds **54** for the formation of elimination products was clearly observed.



Scheme 17

[43] *Synthesis of 2,3-dihydro-imidazo[2,1-*b*]thiazole derivatives* via *cyclization of* N*-allylimidazoline-2-thiones*, M. Jasiński, G. Mlostoń, H. Heimgartner, *J. Heterocycl. Chem.* **2010**, *47*, 1287 [**H13**]

Similarly as for nitrones of type **45** and **48**, in the case of imidazole-2-thiones **53** beneficial influence of the EWG group (R = MeCO, EtO_2C, PhNHCO) located at the C(4) of the heterocycle ring on the reaction course (61-74% yield) was observed. In contrast, alkylated and arylated analogues provided analogous bicyclic products in moderate yields (36-52%), only.

In conlusion – the main goal of the discussed research was the development of new synthetic methods useful for the preparation of polyfunctionalized heterocyclic systems, detailed analysis of the reaction mechanisms (including stereochemical problems in the case of 1,2-oxazine derivatives) as well as physico-chemical characterization of the target compounds. As a final result of the presented studies more than 200 new compounds derived from such hetero- and carbacycles as furane, pyran, oxepane, oxazine, pyrrolidine, azetidine, oxirane, thiirane, thiophene, pyrrole, cyclobutane, imidazole as well as bi- and acyclic products were prepared. Collected results have been described in a series of eleven original papers published in peer-reviewed, high-tier journals, and summarized in two reviews. Selected polyhydroxylated *N*- and *O*-heterocycles prepared within this study were tested as potential inhibitors of selected enzymes (glycosidases), from which several of tested compounds exhibited a promising activity. As an attractive continuation of the studies on application of lithiated alkoxyallenes, the synthesis of polyhydroxylated 6- and 7-membered carbacycles and their fluorinated analogues should be indicated. In addition, lithiated alkoxyallenes **1** can also serve as valuable synthetic equivalents of such organic synthons as acyl anion and methoxycarbonyl group. Furthermore, 2-unsubstituted imidazole 3-oxides **3** can be considered as a unique and still unexplored class of aromatic aldonitrones in such areas as nucleophilic additions and cross-coupling reactions.

6. Other scientific achievements

6.1. Other publications

Papers published in journals listed in Journal Citation Reports (JCR)

List of papers published before receiving PhD:

P1 Reactions of 2-unsubstituted 1*H*-imidazole 3-oxides with 2,2-bis(trifluoromethyl)-ethane-1,1-dicarbonitrile: A stepwise 1,3-dipolar cycloaddition

G. Mlostoń*, M. Jasiński, A. Linden, H. Heimgartner*, *Helv. Chim. Acta*, **2006**, *89*, 1304–1316 (IF_{2006} = 1.550)

My contribution to this publication consisted of: optimization studies and the synthesis of all title compounds, partial analysis of the results, preparation of draft version and further corrections after peer-review. My estimated contribution is calculated to 30%.

P2 Synthesis of new bis-imidazole derivatives

M. Jasiński, G. Mlostoń*, P. Mucha, A. Linden, H. Heimgartner*, *Helv. Chim. Acta* **2007**, *90*, 1765–1780 (IF_{2007} = 1.515)

My contribution to this publication consisted of: partial design of structure and the synthetic route towards title compounds, optimization studies, synthesis of all compounds described in paper, analysis

of the results, preparation of experimental part of the manuscript and its further corrections. My estimated contribution is calculated to 40%.

P3 1,1'-Bis(3-hydroxypropyl)ferrocene: Preparation and substitution with polyfluoroalkyl groups

A. Jankowiak, M. Jasiński, P. Kaszyński*, *Inorg. Chim. Acta* **2007**, *360*, 3637–3641 (IF_{2007} = 1.713)

My contribution to this publication consisted of: optimization of the reactions leading to title compound, synthesis of polyfluorinated derivatives, analysis of the experimental data and preparation of experimental part of the manuscript. My estimated contribution is calculated to 25%.

P4 A new approach to enatiomerically pure bis-imidazoles derived from *trans*-1,2-diaminocyclohexane

P. Mucha, G. Mlostoń*, M. Jasiński, A. Linden, H. Heimgartner*, *Tetrahedron: Asymmetry* **2008**, *19*, 1600–1607 (IF_{2008} = 2.796)

My contribution to this publication consisted of: initial experiments in elaboration of the methods leading to title compounds, synthesis of a series of target molecules (all racemates), analysis of the experimental data, writing of the draft version of manuscript (experimental part and discussion) and its further corrections. My estimated contribution is calculated to 30%.

P5 Evaluation of carborane-containing nematic liquid crystals for electro-optical applications

M. Jasiński, A. Jankowiak, A. Januszko, M. Bremer, D. Pauluth, P. Kaszyński*, *Liq. Cryst.* **2008**, *35*, 343–350 (IF_{2008} = 1.132)

My contribution to this publication consisted of: synthesis of key precursors and selected target compounds, analysis of the results, preparation of experimental part of the manuscript. My estimated contribution is calculated to 50%.

P6 Reactivity of 13,13-dibromo-2,4,9,11-tetraoxadispiro[5.0.5.1]tridecane towards organolithiums: Remarkable resistance to the DMS rearrangement

W. Eccles, M. Jasiński, P. Kaszyński*, K. Zienkiewicz, B. Stulgies, A. Jankowiak, *J. Org. Chem.* **2008**, *73*, 5732–5744 (IF_{2008} = 3.952)

My contribution to this publication consisted of: optimization studies and the reactions of title compound with organyllithiums, analysis of the results (in parts), preparation of selected paragraphs of the experimental part of the manuscript. My estimated contribution is calculated to 30%.

P7 Synthesis and selected transformations of imidazole 3-oxides derived from amino acid esters

M. Jasiński*, G. Mlostoń, A. Linden, H. Heimgartner*, *Helv. Chim. Acta* **2008**, *91*, 1916–1933 (IF_{2008} = 1.396)

My contribution to this publication consisted of: partial design of the structures and elaboration of the synthetic strategies for the preaparation of title compounds, initial syntheses, optimizations of procedures, synthesis of all compounds described in paper, analysis of the results, preparation of draft version, its further corrections, and the correspondence with the editor. My estimated contribution is calculated to 40%.

List of papers published after receiving PhD (without papers listed in chapter 5.2.):

P8 Exploration of 4,5-dimethyl-1*H*-imidazole *N*-oxide derivatives in the synthesis of new achiral and chiral ionic liquids

G. Mlostoń, J. Romański, M Jasiński*, H. Heimgartner*, *Tetrahedron: Asymmetry* **2009**, *20*, 1073–1080 (IF_{2009} = 2.625)

My contribution to this publication consisted of: design of the structures and elaboration of the synthetic strategies for the preparation of title compounds, synthesis of selected compounds described in paper, analysis of the results, preparation of draft version, its further corrections, and preparation of final publication. My estimated contribution is calculated to 50%.

P9 Synthesis and selected transformations of 3-oxido-1*H*-imidazole-4-carboxamides

G. Mlostoń, M. Jasiński*, *Collect. Czech. Chem. Commun.* **2010**, *75*, 871–885 (IF_{2010} = 0.853)

My contribution to this publication consisted of: design of the structures and elaboration of the synthetic strategies for the preparation of title compounds, initial syntheses, optimizations of procedures, synthesis of all compounds described in paper, analysis of the results, preparation of draft version, its further corrections, and the correspondence with the editor. My estimated contribution is calculated to 70%.

P10 First synthesis of the *N*(1)-bulky substituted imidazole 3-oxides and their complexation with hexafluoroacetone hydrate

G. Mlostoń*, M. Jasiński, *ARKIVOC* **2011**, (*vi*), 162–175 (IF_{2011} = 1.252)

My contribution to this publication consisted of: synthesis of all compounds described in paper, analysis of the results and preparation of first version of the manuscript. My estimated contribution is calculated to 50%.

P11 Towards new imidazole-2-thione-based organocatalysts; Sulfur transfer *vs*. deoxygenation in the reaction of imidazole *N*-oxides and cycloaliphatic thioketones

D. Rygielska-Tokarska, M. Jasiński*, G. Mlostoń, H. Heimgartner, *Phosphorus, Sulfur, and Silicon* **2013**, *188*, 469–472 (conference communication, *25th ISOCS*, 24-29.06.2012, Częstochowa) (IF_{2013} = 0.827)

My contribution to this publication consisted of: performing of the additional experiments which confirmed the postulated mechanism, analysis of the results, preparation of draft version of the manuscript, and the correspondence with the editor. My estimated contribution is calculated to 25%.

P12 Mandelic acid derived α-aziridinyl alcohols as highly efficient ligands for asymmetric additions of zinc organyls to aldehydes

M. Rachwalski*, S. Jarzyński, M. Jasiński, S. Leśniak, *Tetrahedron: Asymmetry* **2013**, *24*, 689–693 (IF_{2013} = 2.165)

My contribution to this publication consisted of: design of the title compounds (in parts), partial preparation of draft version and its further corrections. My estimated contribution is calculated to 10%.

P13 A 'click' [3+2]-cycloaddition approach to novel Cookson's birdcage-derived thiacrown ethers

M. Stefaniak, M. Jasiński, J. Romański*, *Synthesis* **2013**, 2245–2250 (IF_{2013} = 2.443)

My contribution to this publication consisted of: partial activity in design of the title compounds, preparation of draft version and its further corrections. My estimated contribution is calculated to 20%.

P14 Functional group transformations in derivatives of 6-oxoverdazyl

M. Jasiński, J. S. Gerding, A. Jankowiak, K. Gębicki, J. Romański, K. Jastrzębska, A. Sivaramamoorthy, K. Mason, D H. Evans, M. Celeda, P. Kaszyński*, *J. Org. Chem.* **2013**, *78*, 7445–7454 (IF_{2013} = 4.638)

My contribution to this publication consisted of: partial activity in design of the synthetic strategy, synthesis of selected title compounds, development of the selected title trnsformations, analysis of the results, and preparation of experimental part of the manuscript. My estimated contribution is calculated to 35%.

P15 Temperature-dependent polymorphism of *N*-(4-fluorophenyl)-1,5-dimethyl-1*H*-imidazole-4-carboxamide 3-oxide: experimental and theoretical studies on intermolecular interactions in the crystal state

A. J. Rybarczyk-Pirek*, M. Łukomska, K. Ejsmont, M. Jasiński, M. Palusiak, *Struct. Chem.* **2014**, *25*, 979–989 (IF_{2014} = 1.837)

My contribution to this publication consisted of: synthesis of the title compound, preparation of part of the manuscript dealing with the synthesis and its further corrections. My estimated contribution is calculated to 5%.

P16 Reduction of thiocarbonyl compounds with lithium diisopropylamide

A. Gebert, M. Jasiński, G. Mlostoń, H. Heimgartner*, *Helv. Chim. Acta.* **2014**, *97*, 931–938 (IF_{2014} = 1.138)

My contribution to this publication consisted of: reactions with classical cycloaliphatic thioketones, analysis of the results, partial activity in preparation of the manuscript and its further corrections. My estimated contribution is calculated to 30%.

P17 Tetragonal phase of 6-oxoverdazyl bent-core derivatives with photoinduced ambipolar charge transport and electrooptical effects

M. Jasiński, D. Pociecha, H. Monobe, J. Szczytko, P. Kaszyński*, *J. Am. Chem. Soc.* **2014**, *136*, 14658–14661 (IF_{2014} = 12.113)

My contribution to this publication consisted of: partial activity in design of the title molecules, synthesis of all compounds described in the paper, thermal and optical analysis of target materials, analysis of the results, preparation of the experimental and discussion parts of the manuscript dealing with the synthesis; activity in further corrections and the preparation of final publication. My estimated contribution is calculated to 35%.

P18 Tautomeric equilibrium in trifluoroacetaldehyde arylhydrazones

A. Wojciechowska, M. Jasiński*, P. Kaszyński, *Tetrahedron* **2015**, *71*, 2349–2356 (IF_{2015} = 2.641)

My contribution to this publication consisted of: design of the studies, synthesis of selected model compounds, kinetic studies, partial activity in analysis of the results, preparation of draft version, its further corrections, preparation of the final version of publication and correspondence with the editor. My estimated contribution is calculated to 60%.

P19 3-Substituted 6-oxoverdazyl bent-core nematic radicals: synthesis and characterisation

S. Ciastek, M. Jasiński, P. Kaszyński*, *RSC Adv.* **2015**, *5*, 33328–33333 (IF_{2015} = 3.840)

My contribution to this publication consisted of: partial activity in design of the title molecules, synthesis of selected target compounds, partial activity in optical and thermal analysis of the materials, analysis of the results, partial activity in preparation of draft and further corrections of the manuscript. My estimated contribution is calculated to 20%.

P20 Synthesis of sulfur-rich crown ethers *via* azide-alkyne macrocyclisation of α,ω-diazido- and α,ω-dipropargyl sulfide derivatives

M. Stefaniak, M. Jasiński, J. Romański*, *Synlett* **2015**, *26*, 1045–1048 (IF_{2015} = 2.419)

My contribution to this publication consisted of: partial activity in design of the title molecules, preparation of draft version, its further corrections and polishing of the final manuscript. My estimated contribution is calculated to 20%.

P21 Lithium diisopropylamide (LDA) as an efficient reducing agent for thioketones – mechanistic consideration

M. Jasiński, G. Mlostoń*, A. Gebert, H. Heimgartner, *Phosphorus, Sulfur, and Silicon* **2015**, *190*, 1281–1284 (conference communication, *26th ISOCS*, 24-29.08.2014, Istanbul, Turkey) (IF_{2015} = 0.561)

My contribution to this publication consisted of: partial activity in experimental work and analysis of the results. My estimated contribution is calculated to 15%.

P22 Bent-core 6-thioxoverdazyl: a comparison of mesogenic properties with the 6-oxo analogue
M. Jasiński, K. Gębicki, P. Kaszyński*, *Liq. Cryst.* **2015**, *42*, 982–988 (IF_{2015} = 2.486)

My contribution to this publication consisted of: synthesis of all 6-oxoverdazyl derivatives, partial synthesis of 6-thioxo series, physico-chemical analysis of the title compounds, partial activity in the preparation of draft (experimental and discussion on the synthesis), further corrections of the manuscript. My estimated contribution is calculated to 45%.

Papers published in journals other than those listed in JCR (without papers listed in chapter 5.2.):

P23 Direct synthesis of organic azides and thiols derived from ethylene glycol *via* modified Appel reaction
M. Stefaniak*, M. Jasiński, K. Urbaniak, P. Seliger, N. Gutowska, J. Romański, *CHEMIK* **2014**, *68*, 592–599 (MNiSW = 8 pkt)

My contribution to this publication consisted of: partial activity in design and elaboration of the synthetic strategies for the preparation of title compounds, partial activity in preparation of draft version, and further corrections of the manuscript. My estimated contribution is calculated to 15%.

6.2. Conference contribution

The results of ongoing studies were presented on domestic and international scientific meetings (overall: 73 contributions: 41 domestic, 32 international) as posters and oral communications (a dozen or so oral lectures including four invited lectures)

Selected oral communications and posters presented on international scientific meetings

K1 A. Wróblewska, M. Jasiński, Four decades of imidazole *N*-oxide chemistry at the University of Łódź. *18th International Symposium „Advances in the Chemistry of Heteroorganic Compounds"*, 20.11.2015, Łódź, P-001 (poster)

K2 M. Jasiński, S. Ciastek, S. Kapuściński, D. Pociecha, H. Monobe, P. Kaszyński, Induction of liquid crystalline phases by the CF_3 group in 6-oxoverdazyl derivatives. *7th International Meeting on Halogen Chemistry*, 3-6.09.2015, Częstochowa, L-07 (oral communication)

K3 G. Utecht, M. Jasiński, Synthesis of highly functionalized oxepanes by Brønsted acid-mediated cyclisation of 1,2-oxazine derivatives. *19th European Symposium on Organic Chemistry*, 12-16.07.2015, Lisbon (Portugal), P-25 (poster)

K4 M. Stefaniak, M. Jasiński, P. Seliger, N. Gutowska, J. Romański, Huisgen-Sharpless-Meldal approach to sulfur-rich crown ethers. *VIIIth International Mini-Symposium 'The Huisgen Cycloaddition Reaction as a Universal Tool for Exploration in Chemistry; Biology, and Medicine'*, 25.05.2015, Łódź, SL-1 (invited lecture)

K5 M. Jasiński, Liquid crystalline verdazyls. *(Old and) New Aspects of Organic Chemistry*, 09-10.05.2015, Berlin (Germany), L-6 (invited lecture)

K6 M. Jasiński, G. Mlostoń, Reactions of thioketones with lithiated agents – A new routes to vinylthiiranes and sulfides. *5th International Conference on Advances in Chemistry and Applied Chemistry*, 21-23.10.2014, Cairo (Egypt), PL-7 (invited lecture)

K7 M. Jasiński, G. Mlostoń, Three carbons in a row – lithiated alkoxyallenes as versatile building blocks for the synthesis of *N*-, *O*-, and *S*-heterocycles. *XVIIth International Symposium 'Advances in the Chemistry of Heteroorganic Compounds'*, 21.11.2014, Łódź, P-074 (poster)

K8 M. Jasiński, G. Mlostoń, A. Gebert, H. Heimgartner, Lithium diisopropylamide (LDA) as an efficient reducing agent for thioketones. *26th International Symposium on Organic Chemistry of Sulfur*, 24-29.08.2014, Istanbul, Turkey, PP-A27 (poster)

K9 M. Jasiński, A. Bodzioch, J. S. Gerding, D. Pociecha, H. Monobe, J. Szczytko, P. Kaszyński, Bent-core mesogenic derivatives of π-delocalized radicals. *25th International Liquid Crystal Conference*, 29.06-04.07.2014, Dublin (Ireland), BC-O2.001 (oral communication)

K10 A. Jankowiak, D. Pociecha, J. Szczytko, H. Monobe, J. S. Gerding, K. Gębicki, M. Jasiński, P. Kaszyński, Synthesis of functionalisable 6-oxoverdazyls. *VIth International Mini-Symposium 'Current Problems in Materials Chemistry'*, 23.05.2013, Łódź, L-9 (invited lecture)

K11 M. Jasiński, H.-U. Reissig, Application of L-erythrose derived nitrones in the synthesis of polyhydroxylated compounds. *Łódź-Giessen Chemistry Workshop*, 10-14.10.2012, Łódź, L-14 (oral communication)

K12 M. Jasiński, H.-U. Reissig, Exploration of new 1,2-oxazines in the synthesis of polyhydroxylated compounds. *14th Blue Danube Symposium on Heterocyclic Chemistry*, 26-29.06.2011, Podbanske (Slovakia), PO-35 (poster)

K13 M. Jasiński, G. Mlostoń, W. Strzelczyk, P. Sobieszczyk, M. Palusiak, A. Palusiak, Remarkable stability of *N*-oxides derived from imidazole-4-carboxamides; Synthesis, structural analysis and microbiological studies. *16th European Symposium on Organic Chemistry*, 12-16.07.2009, Prague (Czech Republic), P1.228 (poster)

Selected oral communications and posters presented on domestic scientific meetings

K14 G. Utecht, M. Jasiński, Synteza enancjomerycznie czystych pirolidynoseptanozydów (*Synthesis of enantiomerically pure pyrrolidinoseptanosides*). *58th Annual Scientific Meeting of the Polish Chemical Society*, 21-25.09.2015, Gdańsk, S03P180 (poster)

K15 S. Kapuściński, P. Kaszyński, M. Jasiński, Nowe mezogeny 6-oksowerdazylowe o architekturze kija hokejowego (*New 6-oxoverdazyl mesogens of hockey-stick architecture*). *58th Annual Scientific Meeting of the Polish Chemical Society*, 21-25.09.2015, Gdańsk, S03P107 (poster)

K16 M. Jasiński, P. Grzelak, G. Mlostoń, Metoksyallen w syntezie heterocykli siarkowych (*Methoxyallene in the synthesis of sulfur-containing heterocycles*). *Xth National Symposium on Organic Chemistry*, 16-18.04.2015, Łódź, K-05 (oral communication)

K17 G. Utecht, M. Jasiński, Próby wykorzystania litowanych alkoksyallenów oraz δ-sililoksynitronów w syntezie pochodnych oksepanu (*Attempts in application of lithiated alkoxyallenes and δ-siloxynitrones in the synthesis of oxepane derivatives*). *Xth National Symposium on Organic Chemistry*, 16-18.04.2015, Łódź, P-117 (poster)

K18 G. Utecht, B. Busiak, M. Jasiński, Anion alkoksyallenowy w syntezie pochodnych pirolizydyny i indolizydyny (*Alkoxyallene anion in the synthesis of pyrrolizidine and indolizidine derivatives*). *IIIrd Doctoral Symposium on Chemistry in Łódź*, 27-28.04.2015, Łódź, P-72 (poster)

K19 M. Jasiński, A. Jankowiak, D. Pociecha, J. S. Gerding, K. Gębicki, P. Kaszyński, J. Romański, Synteza pochodnych 6-oksowerdazylu jako nowych materiałów ciekłokrystalicznych (*Synthesis of 6-oxoverdazyl derivatives as a new liquid crystalline materials*). *56th Annual Scientific Meeting of the Polish Chemical Society*, 16-20.09.2013, Siedlce, S01-K08

K20 M. Jasiński, T. Watanabe, H.-U. Reissig, Redukcje pochodnych 3,6-dihydro-2*H*-1,2-oksazyny indukowane jodkiem samaru (SmI_2) [*Samarium diiodide (SmI_2)-induced reductions of 3,6-dihydro-2H-1,2-oxazine derivatives*]. *"Progress in the synthesis of nonracemic compounds" – VIth Seminar of the Organic Chemistry Section of the Polish Chemical Society*, 16-19.10.2012, Polanica Zdrój, K-35 (oral communication)

K21 G. Mlostoń, M. Jasiński, Nieoczekiwany przebieg ‘reakcji przeniesienia siarki’ z użyciem sterycznie zatłoczonych *N*-tlenków imidazolu oraz 2,2,4,4-tetrametylocyklobutan-1,3-ditionu (*Unexpected course of the ‘sulfur transfer reaction’ with the use of sterically hindered imidazole N-oxides and 2,2,4,4-tetramethylcyclobutane-1,3-thione*). *XIIIth National Symposium of the Heteroorganic Chemistry Section of the Polish Chemical Society*, 19.11.2010, Łódź, P-3 (poster)

K22 M. Jasiński, G. Mlostoń, Synteza i wybrane transformacje optycznie czynnych *N*-tlenków imidazolu pochodnych estrów aminokwasów (*Synthesis and selected transformations of optically active imidazole N-oxides derived from amino acid esters*). *”Progress in the synthesis of nonracemic compounds” – IVth Seminar of the Organic Chemistry Section of the Polish Chemical Society*, 16-18.10.2008, Szklarska Poręba, K-15 (oral communication)

K23 M. Jasiński, G. Mlostoń, H. Heimgartner. Syntezy i wybrane transformacje *N*-tlenków imidazolu funkcjonalizowanych grupą estrową lub alkiloestrową (*Syntheses and selected transformations of imidazole N-oxides functionalized with ester or alkylester groups*). *VIIIth National Symposium on Organic Chemistry*, 10-12.04.2008, Łódź, K-38 (oral communication)

6.3. Awards for scientific activity

N1 *Medal for Glorious Study* awarded by Academic Senate of University of Łódź (2004)

N2 PhD thesis Distinction by the Chemistry Faculty Council of University of Łódź (2009)

N3 Sigma-Aldrich and Polish Chemical Society Distinction for PhD thesis on organic chemistry defended in 2008 (2009)

N3 Collective Award of the 1st degree by Rector of Łódź University for a series of publications entitled *Heteroatom and heterocyclic compounds – development of the synthetic methods and the structural studies* (2009)

N4 *Kolumb* post-doc fellowship by Foundation for Polish Science (2010)

N5 Collective Award by Minister of Science and Higher Education for a series of publications entitled *Structural studies and developments of the synthetic methods of heteroatom and heterocyclic compounds of potential importance in biology and medicine* (2011)

N6 Collective award *Łódzkie Eureka* (2011)

N7 Collective Award of the 1st degree by Rector of Łódź University for a series of publications entitled *Structures and reactivity of nitrogen and sulfur heterocycles* (2012)

N8 University of Łódź Foundation Scientific Award (2014)

N9 Research Paper of the Year 2014 Award by Dean of the Faculty of Chemistry (2015)

N10 Scholarship for Outstanding Young Scientist by Minister of Science and Higher Education (2015)

N11 Special Rector Award for Scientific Achievements published in 2015 (Team-Prize, 2016)

6.4. Abroad academic trainings

S1 three short-term internships (1-2 week(s)), Justus-Liebigs University (Inst. of Org. Chem., prof. P. R. Schreiner group), Giessen, Germany (March 2005, June 2006, September 2009)

S2 two scientific NSF-fellowships, Vanderbilt University, Faculty of Chemistry (Organic Materials Research Group, prof. P. Kaszynski group), Nashville, USA (February-September 2007, February-March 2013)

S3 post-doc stay, Freie Universität Berlin (Institute of Chemistry and Biochemistry – Organic Chemistry, prof. H.-U. Reissig group), Berlin, Germany (December 2010-February 2012)

6.5. Scientific grants

G1 KBN grant no. PBZ-KBN-126/T09/2004; *New chiral and achiral imidazole ligands for enantio- and diastereoselective cyclopropanation and aziridination*; *Attempts for the synthesis of chiral ionic liquids* (2006-2009), University of Łódź; investigator.

G2 UŁ grant no. 505/712; *New synthetic methods and new transformations of heteroatom and heterocyclic compounds* (2007), *Studies on the reactive heteroatom-containing compounds* (2008/09), *Studies on the chemistry of heteroatom and heterocyclic compounds* (2009/10). University of Łódź; investigator.

G3 KBN grant no. PBZ-KBN NN/204/130335; *New nucleophilic trifluoromthylation reaction by using (trifluoromethyl)trimethylsilane* CF_3SiMe_3 (2008-2011). University of Łódź; investigator.

G4 UŁ grant no. 545/089 (2011); *Chiral fluoroorganic and nitrogen heterocycles as a new ligands for the stereocontrolled synthesis*. University of Łódź; project leader.

G5 NCN grant „Opus", No. 2011/01/B/ST5/06582; *Synthesis and characterization of new materials containing functionalized verdazyl radical* (2011-2014). University of Łódź; primary investigator.

G6 NCN grant „Opus", No. 2011/01/B/ST5/06613; *Synthesis and studies on complexing properties of new macrocyclic compounds with build-in lipophilic moieties* (2011-2014). University of Łódź; primary investigator.

G7 UŁ grant, No. 545/335 (2012); *Synthesis and applications of nonracemic nitrones in asymmetric Kinugasa reaction*. University of Łódź; project leader.

G8 NCN grant „Maestro", No. 2012/06/A/ST5/00219; *Heteroaromatic thioketones as unique substrates and building blocks for exploration in organic, materials, coordination, and biometaloorganic chemistry* (2013-2018). University of Łódź; investigator.

G9 NCN grant „Opus", No. 2013/09/B/ST5/01230; *Synthesis and characterization of bent-core mesogens derived from 6-oxoverdazyl radical* (2014-2017); University of Łódź; project leader.

G10 MNiSW grant „Iuventus Plus", No. IP2014 017173; *Well-matched couple: alkoxyallenes and nitrones in the synthesis of natural products and their analogues* (2015-2017). University of Łódź; project leader.

6.6. Other teaching, scientific and organizing activities

Reviews

- reviews of bachelor's and master's thesis at the Faculty of Chemistry, Univerity of Łódź

- peer-reviews of original and review papers considered for publication in the following journals of JCR list:

Central European Journal of Chemistry
Journal of Sulfur Chemistry
Arabian Journal of Chemistry
Phosphorus, Sulfur, and Silicon and the Related Elements
Molecules

Activity in organizing of scientific conferences

- VIIIth National Symposium on Organic Chemistry, 10-12.04.2008, Łódź

- 52nd Annual Scientific Meeting of the Polish Chemical Society, 12-16.09.2009, Łódź

- Łódź-Giessen Chemistry Workshop,10-14.10.2012, Łódź

- VIth International Mini-Symposium *Current Problems in Materials Chemistry*, 23.05.2013, Łódź

- VIIth International Mini-Symposium *Heteroatom containing compounds on the borderline of chemistry, biology, and medicine*, 21-22.05.2014, Łódź

- 57th Annual Scientific Meeting of the Polish Chemical Society, 14-18.09.2014, Częstochowa

- VIIIth International Mini-Symposium *The Huisgen cycloaddition reaction as a universal tool in chemistry, biology, and medicine*, 25.05.2015, Łódź

Promotion of science and education

- Academy of Interesting Chemistry at the Chemistry Faculty of the University of Łódź for high school students (lecturer since 2009)

- news about ongoing projects, team members, instrumentation, results and recent papers could be found on author's webpage at: http://www.chemia.uni.lodz.pl/doctors/jasinski

Teaching

Laboratory courses, seminars and lectures

- laboratory courses and seminars given to students of Chemistry Faculty (all years of bachelor and master study) and students of Biology and Environmental Protection Faculty (bachelor level) covered various aspects of organic and bioorganic chemistry (since 2005)

- ongoing classes and lectures (since academic year 2013/2014):

organic chemistry B1 (laboratory), bachelor level, 20 h

biochemistry (laboratory), bachelor level, 20 h

organic chemistry B2 (seminar), bachelor level, 28 h

undergraduate thesis seminar, bachelor level, 28 h

organic chemistry A3 (seminar), master level, 28 h

spectroscopy A (laboratory), master level, 9 h

modern methods of total synthesis (lecture), master level, 28 h

Scientific assistance to students

- bachelor (8 thesis) and master thesis (6 thesis, including 2 as supervisor) in the years 2010-2015

- co-promotion of the PhD thesis (1 student, in progress since 2014)

- supervision of experimental work on the basis of *Individual Study Programme* (5 students in the years 2012-2015)

Achievements and initiatives in improvement of didactic process

- introduction of a new lecture given in English entitled *Modern methods of total synthesis* into the faculty schedule (since 2012)

- scientific consultations and review of manual for *Biochemistry Laboratory* by dr E.Obijalska, bachelor level, Universtity of Lodz (2013)

Other information

- member of the Polish Chemical Society (since 2004)
- member of Recruitment Commission at the UŁ (2009)
- contact person for scientific cooperation between Faculty of Chemistry at UŁ and Friedrich Schiller University in Jena (Germany); active participation in preparation of the *basic agreement for cooperation* between the University of Łódź and the Friedrich Schiller University in Jena (coordinated by Professor Grzegorz Mlostoń)

Summarized data of professional accomplishements

	Year	No of papers	IF[a]	Citations[b]
Before receiving PhD	2006	1	1.550	0
	2007	2	3.228	2
	2008	4	9.276	10
After receiving PhD	2009	1	2.625	17
	2010	2	1.815	19
	2011	4	8.232	48
	2012	2	6.145	31
	2013	5	13.227	37
	2014	6	22.740	44
	2015	6	14.102	63
	2016[c]	3[c,d]	4.806	10[c]
Σ	-	**36**	**87.746**	**281**

[a] according to year of publication; [b] according to Scopus database; [c] until March 22nd, 2016; [d] including one paper accepted for publication.