# APPLICATION OF MICROWAVE IRRADIATION TO RAPID TRANSFORMATIONS OF ORGANIC COMPOUNDS AND MACROMOLECULES

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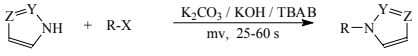
## ORGANIC SYNTHESIS

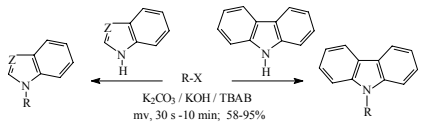
### Alkylation of Azaheterocykles [1-3]



58-95%

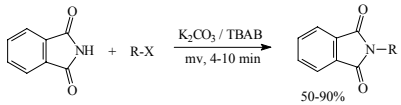
Z,Y = CH: pyrrole; Z = N, Y = CH: imidazole; Z = CH, Y = N: pyrazole

R: benzyl, decyl, pentyl; X = Cl, Br, I



Z = CH: indole; Z = N: benzimidazole;

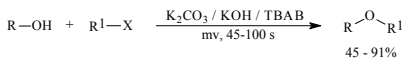
R: benzyl, butyl, pentyl, decyl; X: Cl, Br



50-90%

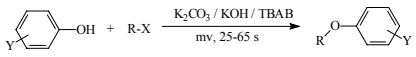
R: benzyl, butyl, decyl, pentyl, 2,3-epoxipropyl; X: Cl, Br, I;

### Williamson Reaction - Synthesis of Ethers [4-5]



45 - 91%

R: butyl, oktyl, decyl; R 1: pentyl, heksyl, oktyl, decyl, allil, benzyl



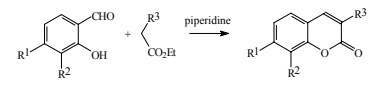
64 - 92%

Y: H, o-Cl, p-Br, p-$NH_2$, m-$CH_3$

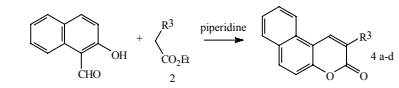
R: butyl, heksyl, oktyl, benzyl; X: Cl, Br (R-X: dimethyl sulfate)

### Condensation Reactions

### Coumarins [6-7]

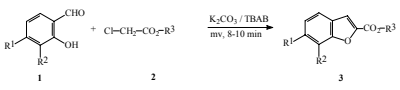


| | $R^1$ | $R^2$ | $R^3$ |
|---|---|---|---|
| **3a**: | H | H | $CO_2Et$ |
| **3b**: | H | H | COMe |
| **3c**: | H | H | CN |
| **3d**: | H | H | p-$O_2N$-$C_6H_4$ |
| **3e**: | H | OMe | $CO_2Et$ |
| **3f**: | H | OMe | COMe |
| **3g**: | H | OMe | CN |
| **3h**: | H | OMe | p-$O_2N$-$C_6H_4$ |
| **3i**: | $Et_2N$ | H | $CO_2Et$ |
| **3j**: | $Et_2N$ | H | COMe |
| **3k**: | $Et_2N$ | H | CN |
| **3l**: | $Et_2N$ | H | p-$O_2N$-$C_6H_4$ |

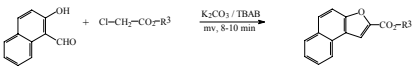


**4a**: $R^3$ = $CO_2Et$; **4b**: $R^3$ = COMe; **4c**: $R^3$ = CN; **4d**: $R^3$ = p-$O_2N$-$C_6H_4$

### Benzofurans [8]

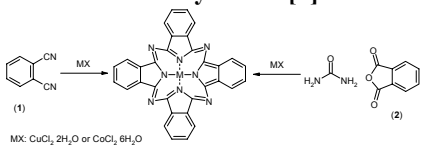


| | $R^1$ | $R^2$ |
|---|---|---|
| **3a:** | H | H |
| **3b:** | H | OMe |
| **3c:** | $Et_2N$ | H |
| **3d:** | H | H |
| **3e:** | H | OMe |
| **3f:** | $Et_2N$ | H |
| **3g:** | H | H |
| **3h:** | H | OMe |
| **3i:** | $Et_2N$ | H |



| | $R^3$ |
|---|---|
| **5a:** | Et |
| **5b:** | $CH_2CH=CH_2$ |
| **5c:** | cyclohexyl |

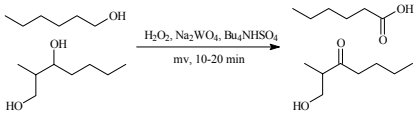
### Phtalocyanines [9]



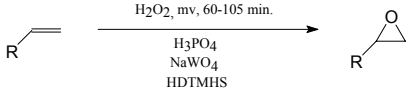
MX: $CuCl_2$ $2H_2O$ or $CoCl_2$ $6H_2O$

### Oxidation reactions

### Oxidation of alcohols [10]

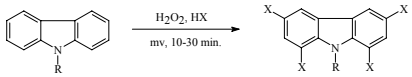


### Epoxidation [11]



HDTMHS - hexadecyltrimethyl hydrogen sulfate

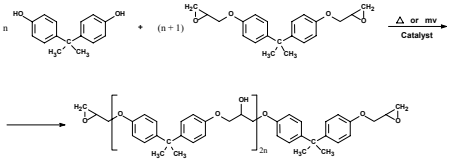
### Oxohalogenation [12]



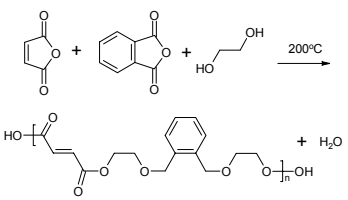
R: H, alkyl; X: Cl, Br

## MACROMOLECULES

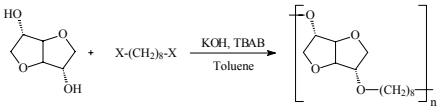
### Epoxy resins [13-16]



### Polyesters [17]

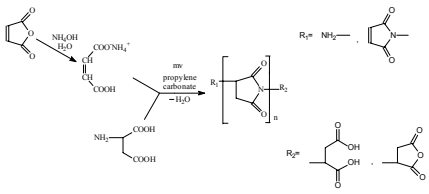


### Polyethers [18-19]

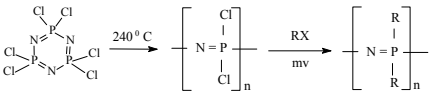


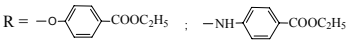
X: Br, OMs

### Poly(aspartic acid)[20-21]



### Polyphosphazenes [22]





### References:

[1] D. Bogdal, J. Pielichowski, K. Jaskot, *Heterocycles*, **1997**, 45, 715

[2] D. Bogdal, J. Pielichowski, K. Jaskot, *Synth. Commun*., **1997**, 27, 1553

[3] D. Bogdal, J. Pielichowski, A. Boron, *Synlett*, **1996**, 37, 873

[4] D. Bogdal, J. Pielichowski, K. Jaskot, *Org. Prep. Proc. Int.*, **1998**, 30, 427

[5] D. Bogdal, J. Pielichowski, A. Boron, *Synth. Commun*., **1998**, 28, 3029

[6] D. Bogdal, *J. Chem. Res. (S)*, **1998**, 468

[7] D. Bogdal, I. Stepien, J. Sanetra, *Current Trends in Polymer Science*, **2002**, 145

[8] D. Bogdal, M. Warzala, *Tetrahedron*, **2000**, 56, 8769

[9] A. Burczyk, A. Loupy, D. Bogdal, A. Petit, *Tetrahedron*, in press

[10] D. Bogdal, M. Lukasiewicz, J. Pielichowski, A. Miciak, S. Bednarz, *Tetrahedron*, **2003**, 59, 649

[11] D. Bogdal, M. Lukasiewicz, S. Bednarz, *Adv. Synt. Catal*., in press

[12] D. Bogdal, M. Lukasiewicz, J. Pielichowski, *Green Chemistry*, **2004**, 6, 110

[13] D. Bogdal, J. Pielichowski, P. Penczek, J. Gorczyk, G. Kowalski, *Polimery*, **2002**, 47 (11-12), 842.

[14] D. Bogdal, J. Gorczyk, *Polish Journal of Chemical Technology*, **2003**, 5(3), 88

[15] D. Bogdal, J. Gorczyk, *Polymer*, **2003**, 44(26), 7795

[16] D. Bogdal, J. Gorczyk, *Journal of Applied Polymer Science*, **2004** - in press

[17] D. Bogdal, J. Gorczyk, E. Wolff, *Polimery,* **2004 -** in press

[18] S. Chatti, M. Bartolussi, A. Loupy, J.C. Blais, D. Bogdal, M. Majdoub, *Eur. Polym. J.*, **2002**, 38, 1851

[19] S. Chatti, M. Bartolussi, A. Loupy, J.C. Blais, D. Bogdal, P. Roger, *J.Appl. Polym. Sci.*, **2003**, 90, 1255

[20] J. Pielichowski, E. Dziki, J. Polaczek, *Polish Journal of Chemical Technology* **2003**, 5(4), 3

[21] J. Polaczek, E. Dziki, J. Pielichowski, *Polimery* **2003**, 28(1), 61

[22] A. Burczyk, D. Bogdal, J. Pielichowski, *Polish Journal of Chemical Technology* **2003**, 5, 96