

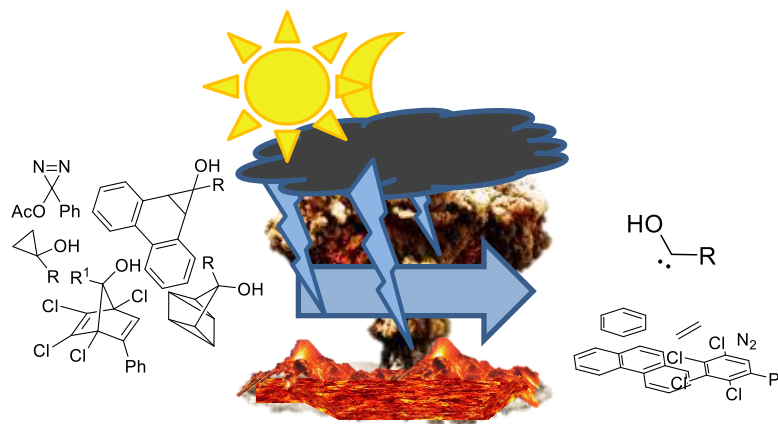


Precursor Towards Hydroxycarbenes in Synthesis

Seminar talk by
Michael Linden, M. Sc.

July 29th, 2016

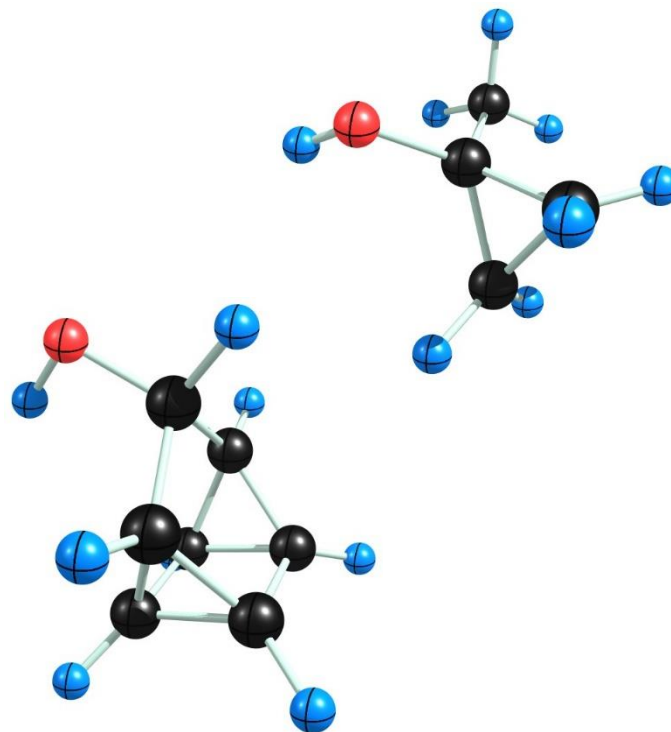
*Institute of Organic Chemistry
Justus-Liebig University Giessen*

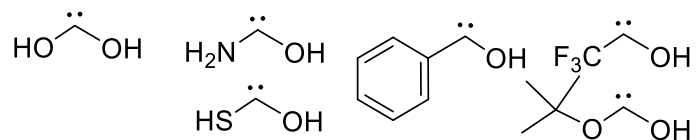
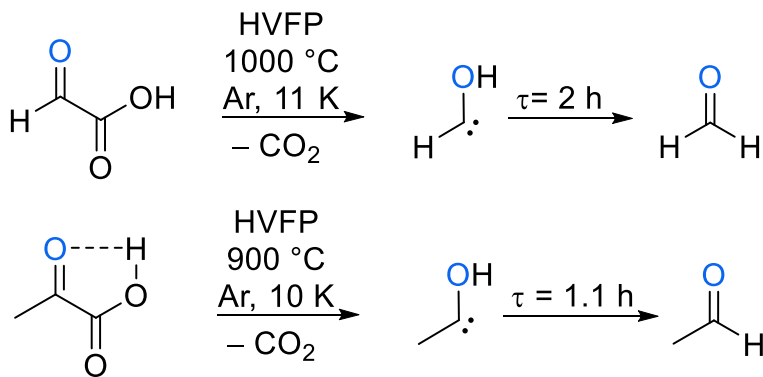




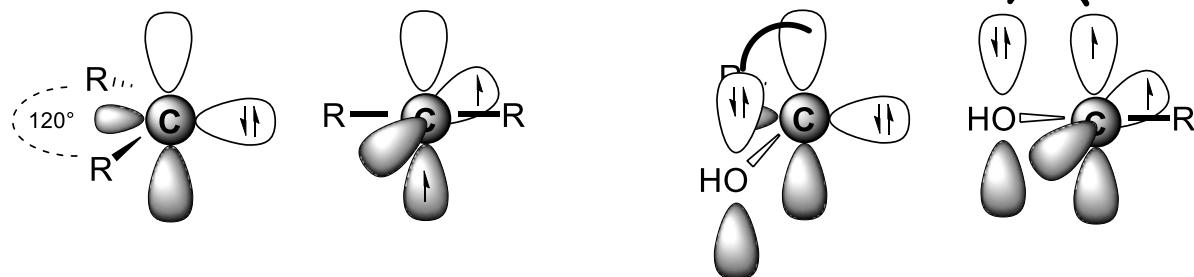
- **State of the art – Hydroxycarbenes**
- **Carbenes in Synthesis**
- **Potential Precursor Molecules**

- **Synthesis of Cyclopropanols**
Matrix-Isolation Studies
- **Synthesis of 7-Hydroxyquadricyclane**
Matrix-Isolation Studies
- **Outlook**



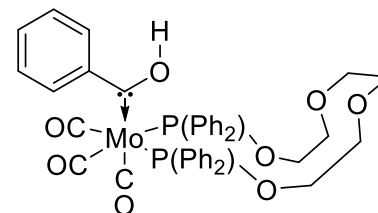


$\longrightarrow$ no synthetic application up to date



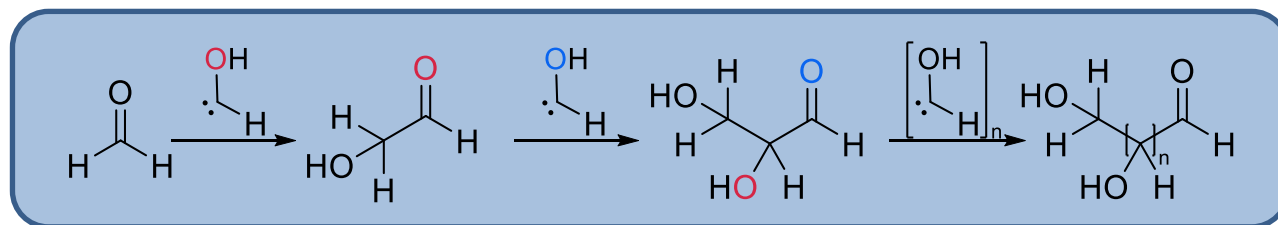
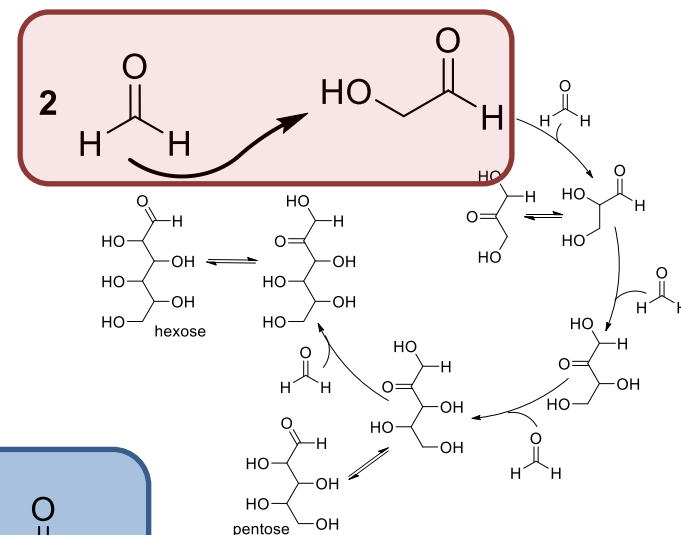
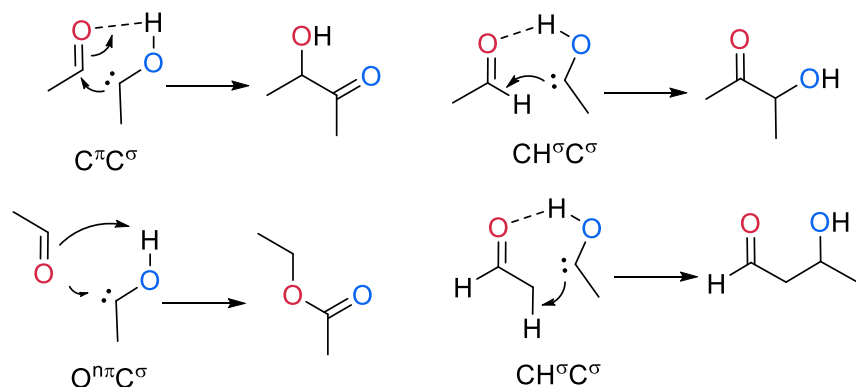
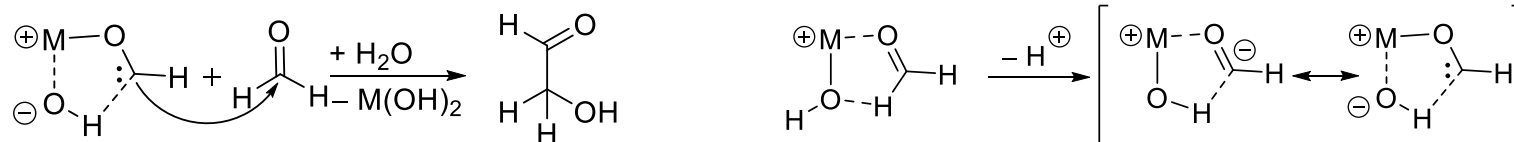
$\Delta E_{\text{singlet-triplet}}$
 $n \rightarrow \pi$

hydroxycarbene metal complexes (Pt, Mn, Cr, W, Re, Os)

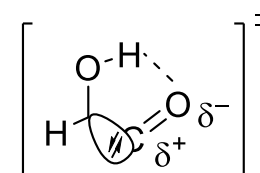


H.-W. Wanzlick *Angew. Chem. Int. Ed.*, **1962**, 74, 129. P. R. Schreiner, H. P. Reisenauer, F. C. Pickard, A. C. Simonett, W. D. Allen, E. Mátyus, A. G. Czásár *Nature*, **2008**, 453, 906. D. Ley, D. Gerbig, P. R. Schreiner, *Org. Biomol. Chem.* **2012**, 10, 3781. P. R. Schreiner, H. P. Reisenauer, D. Ley, D. Gerbig, C.-H. Wu, W. D. Allen *Science* **2011**, 332, 1300. H. T. Le, T. L. Nguyen, D. Lahem, R. Flammang, M. T. Nguyen *Phys. Chem. Phys.* **1999**, 1, 755. J. Powell, D. H. Farrar, S. J. Smith *Inorg. Chim. Acta.* **1984**, 85(1), 23.

State of the art – Hydroxycarbenes



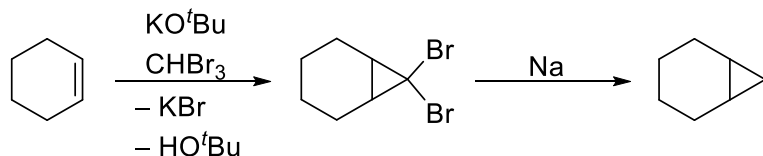
challenge: in solution acidic α -ketocarboxylic acids would be protonated
forming hydroxycarbenes immediately
singlet carbenes are more selective regarding addition reaction



Carbenes in Synthesis



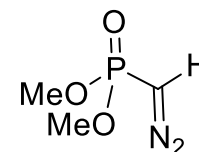
Cyclopropanation



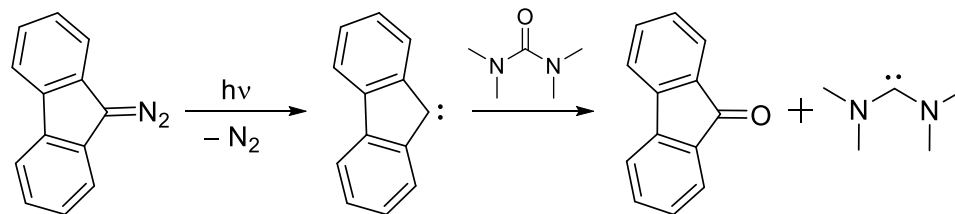
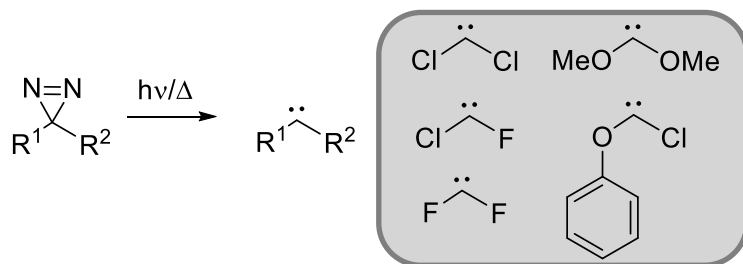
Simmons-Smith CH_2I_2 , Zn/Cu//ZnEt_2
└─ no $:\text{CH}_2$

Bamford-Stevens reaction carbenes in aprotic solvents
and carbenium ions in protic solvents

Seyferth-Gilbert reagent



photolysis of diazarines or epoxides



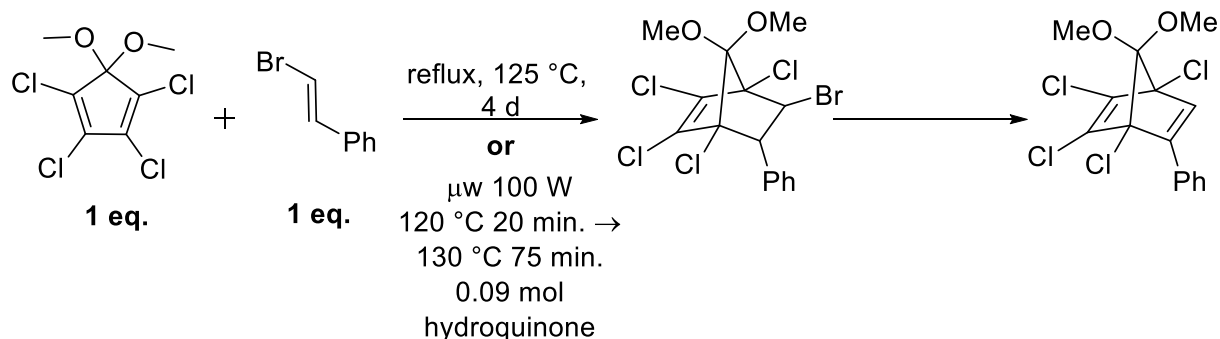
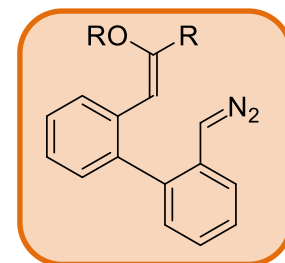
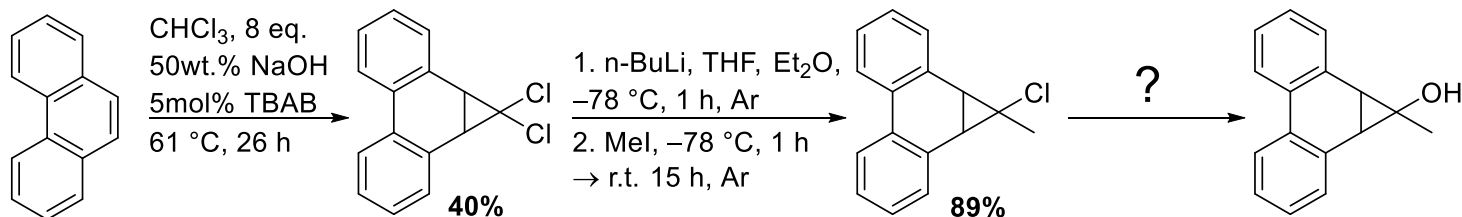
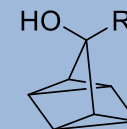
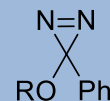
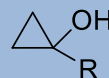
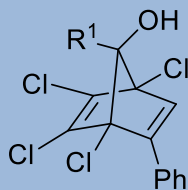
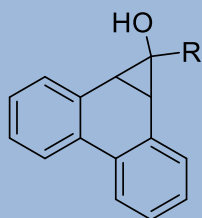
└─ singlet carbenes in reaction

carbenes as catalysts (*NHC*); carbenes as ligands, metathesis

industrial application: Difluorocarbene for Teflon® production

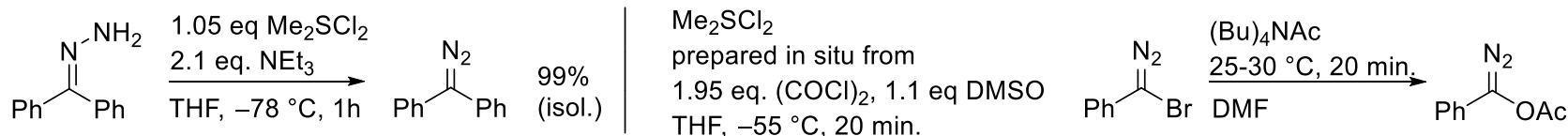
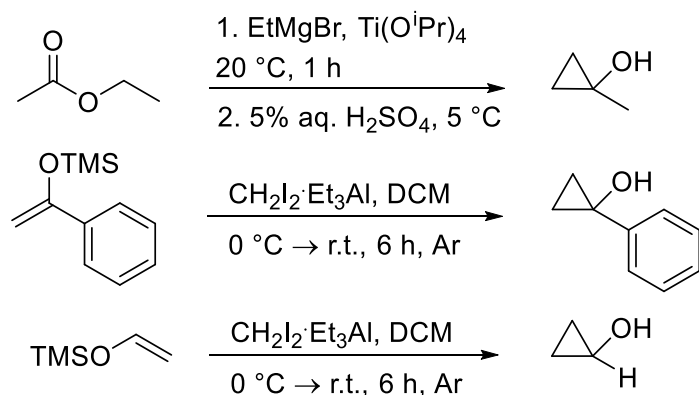
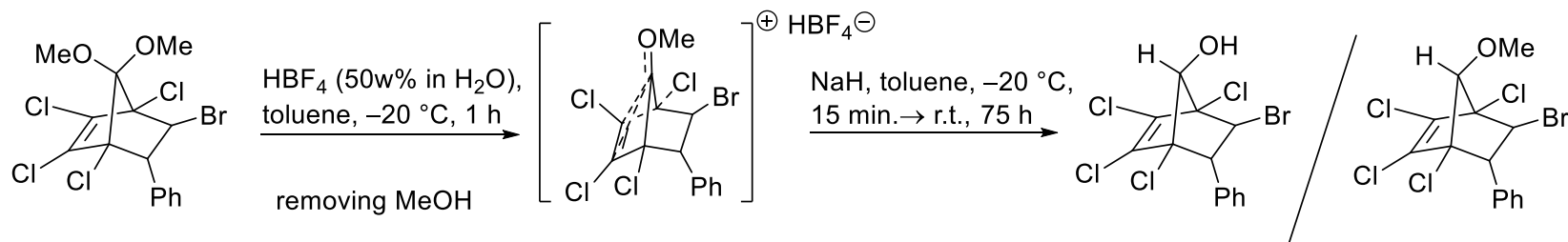
E. Buchner, L. Feldmann *Ber. Dtsch. Chem. Ges.* **1903**, 36(3), 3509. H. Staudinger, O. Kupfer *Ber. Dtsch. Chem. Ges.* **1912**, 45, 501. W. von E. Doering, A. K. Hoffmann *J. Am. Chem. Soc.* **1954**, 76(23), 6162. P. de Frémont, N. Marion, S. P. Nolan *Coordin. Chem. Rev.* **2009**, 253(7), 862. W. R. Bamford, T. S. Stevens *J. Chem. Soc.* **1952**, 4735. D. Seyferth, R. S. Marmor, P. Hilbert *J. Org. Chem.* **1971**, 36(10), 1379.

Potential Precursor Molecules



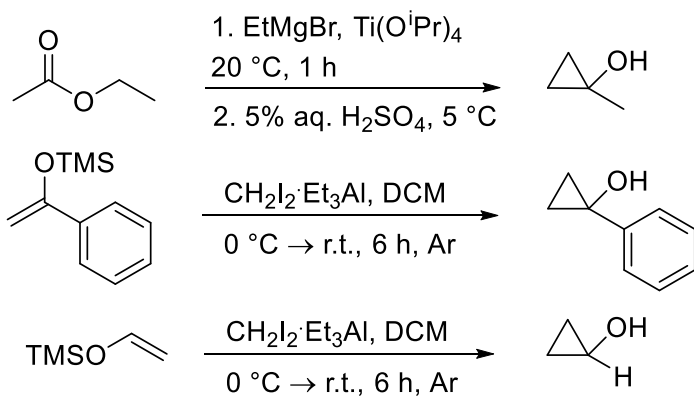
R. W. Hoffmann, H. Häuser, *Tetrahedron* **1965**, 21, 891. R. W. Hoffmann, *Acc. Chem. Res.* **1985**, 18, 248. R. K. Lustgarten, M. Brookhart, S. Winstein *J. Am. Chem. Soc.* **1972**, 94, 2347. G. C. Joshi, N. Singh, L. M. Pande *Tetrahedron Lett.* **1972**, 15, 1461. M. Robert, I. Likhovorik, M. S. Platz, S. C. Abbot, M. M. Kirchhoff, R. Johnson *J. Phys. Chem. A* **1998**, 102, 1507. C. L. Currie, H. Okabe, J. R. McNesby, *J. Phys. Chem.-Us* **1963**, 67, 1494. R. A. Moss, S. Xue, W. Liu *J. Am. Chem. Soc.* **1994**, 116, 1583. C. J. Diehl, master thesis, *Justus-Liebig University* **2015**. M. S. Schuurman, J. Giegerich, K. Pachner, D. Lang, B. Kiendl, R. J. MacDonell, A. Krueger, I. Fischer, *Chem.-Eur. J.* **2015**, 21, 14486.

Potential Precursor Molecules



R. K. Lustgarten, M. Brookhart, S. Winstein *J. Am. Chem. Soc.* **1972**, *94*, 2347. G. C. Joshi, N. Singh, L. M. Pande *Tetrahedron Lett.* **1972**, *15*, 1461. M. Robert, I. Likhovorik, M. S. Platz, S. C. Abbot, M. M. Kirchhoff, R. Johnson *J. Phys. Chem. A* **1998**, *102*, 1507. C. L. Currie, H. Okabe, J. R. McNesby, *J. Phys. Chem.-Us* **1963**, *67*, 1494. O. G. Kulinkovich, S. V. Sviridov, D. A. Vasilevskii, T. S. Pritytskaya *Zh. Org. Khim.* **1989**, *25*, 2244. S. V. Sviridov, D. A. Vasilevskii *Synthesis* **1991**, 234. R. A. Moss, S. Xue, W. Liu *J. Am. Chem. Soc.* **1994**, *116*, 1583. L. Currie, H. Okabe, J. R. McNesby, *J. Phys. Chem.-Us* **1963**, *67*, 1494. R. A. Moss, S. Xue, W. Liu *J. Am. Chem. Soc.* **1994**, *116*, 1583. C. J. Diehl, master thesis, *Justus-Liebig University*, **2015**.

Synthesis of Cyclopropanols

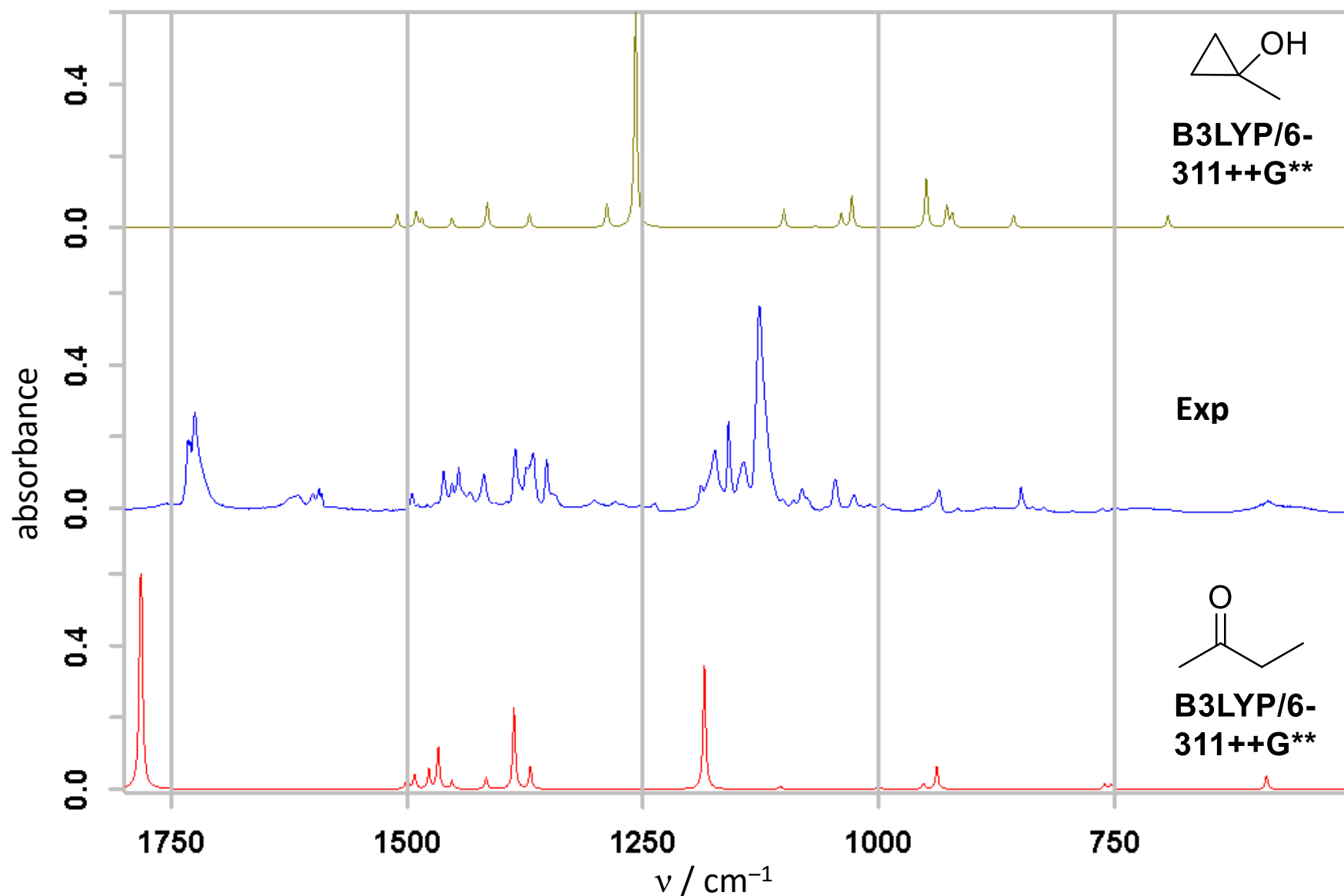


→ always methylketones as byproduct
separation difficult
yield: 37% + 4% ketone

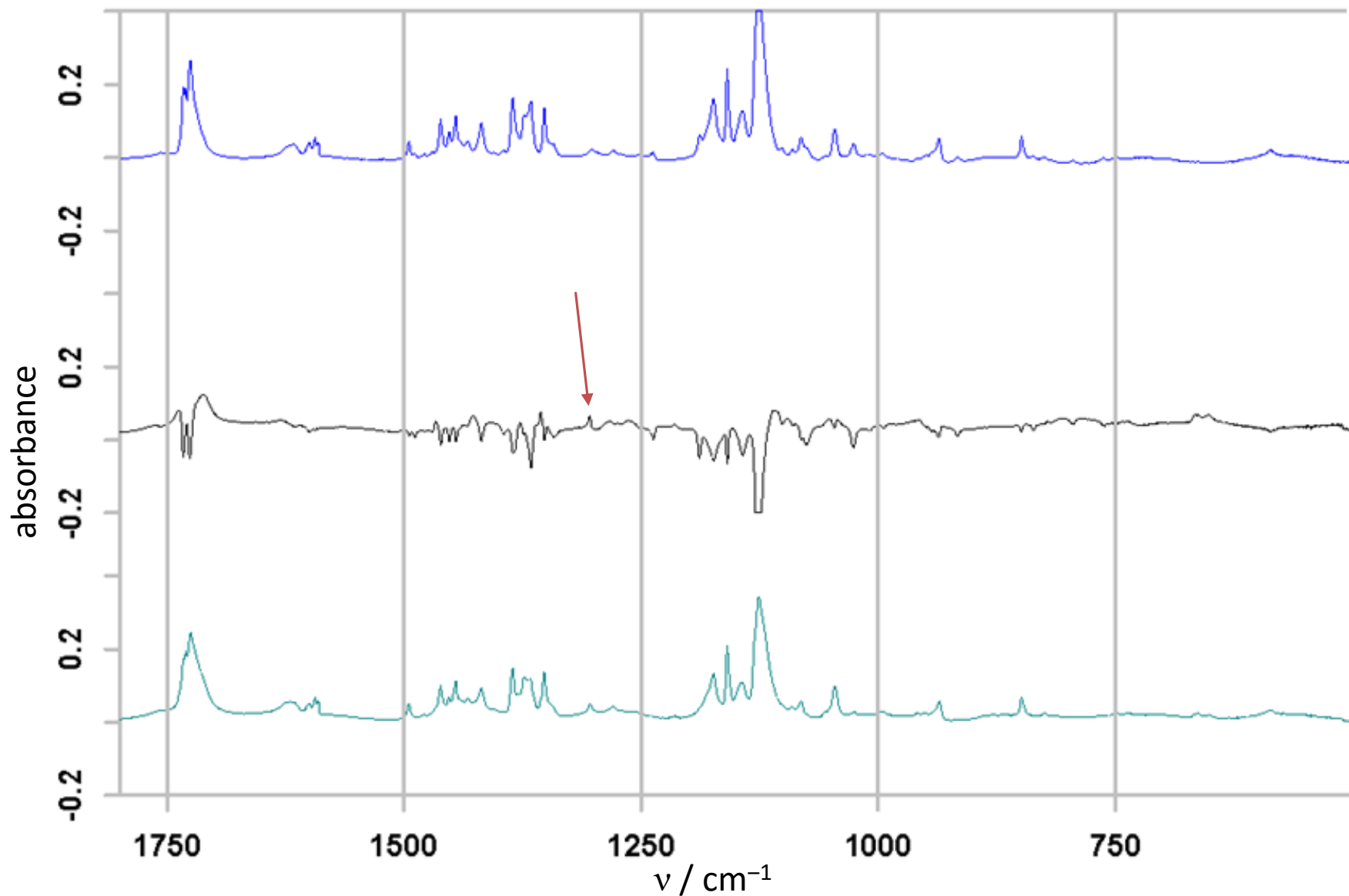


L. Currie, H. Okabe, J. R. McNesby, *J. Phys. Chem.-Us* **1963**, 67, 1494. R. A. Moss, S. Xue, W. Liu *J. Am. Chem. Soc.* **1994**, 116, 1583. C. J. Diehl, master thesis, *Justus-Liebig University*, **2015**.

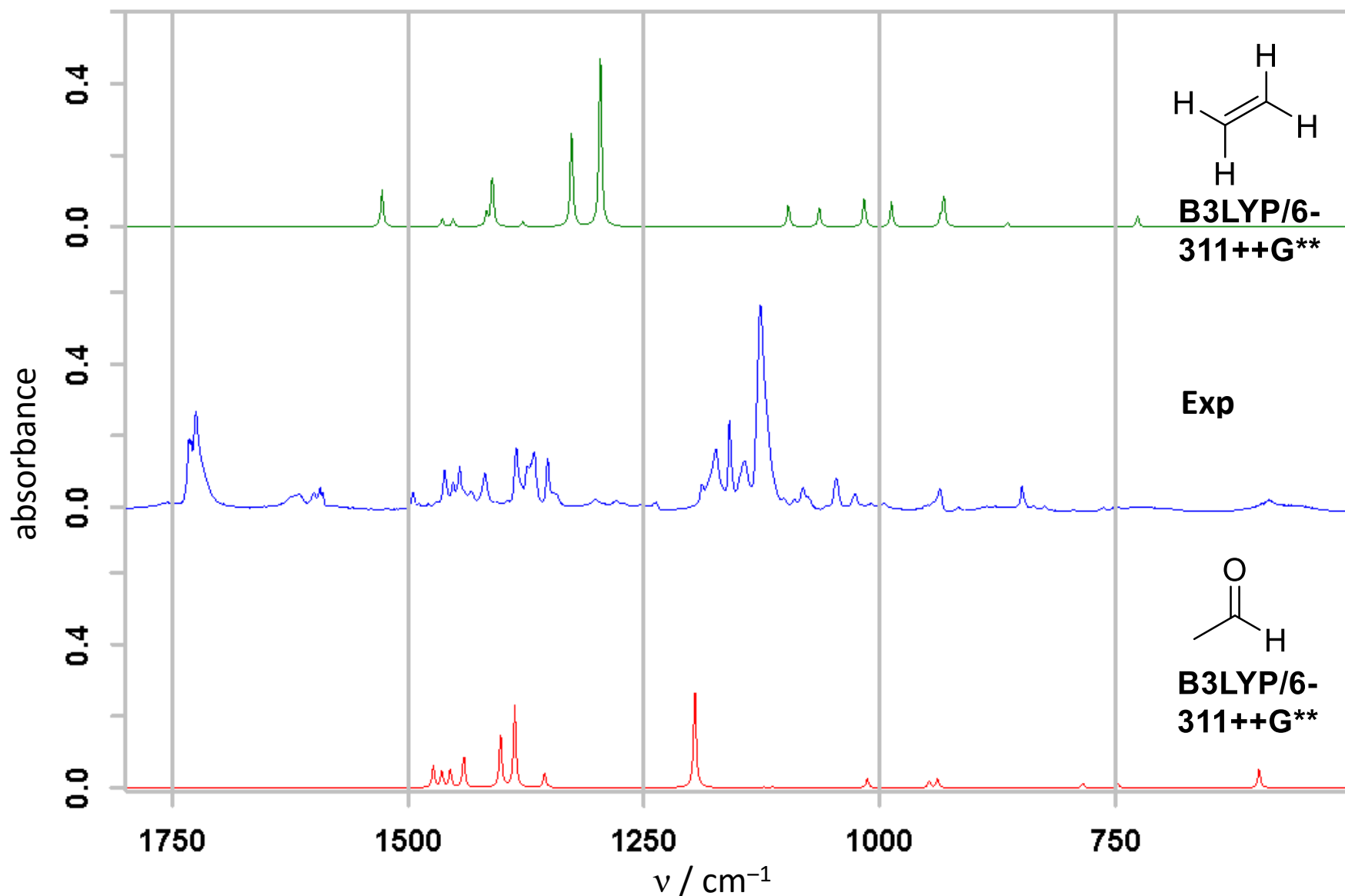
Cyclopropanol – Matrix-Isolation Studies



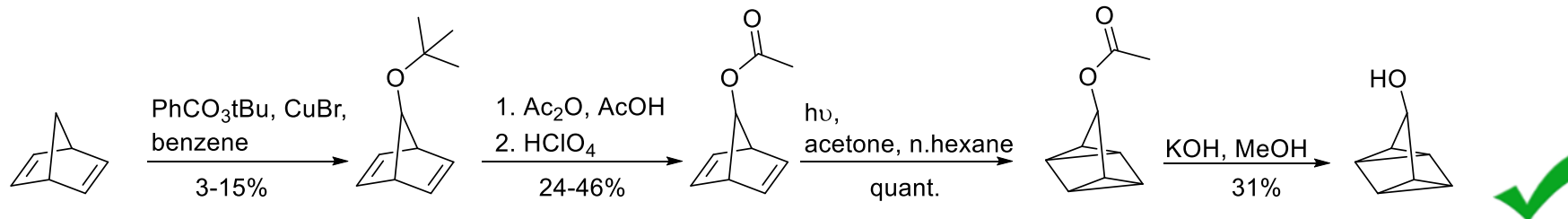
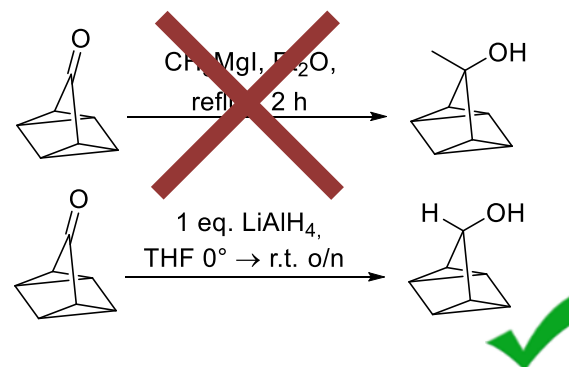
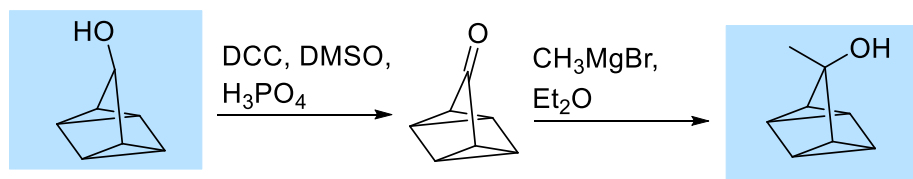
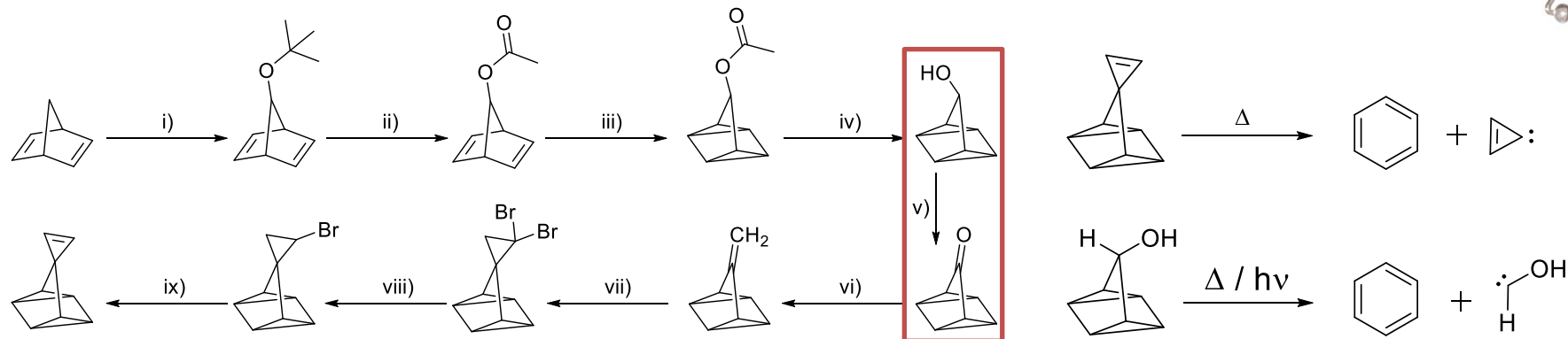
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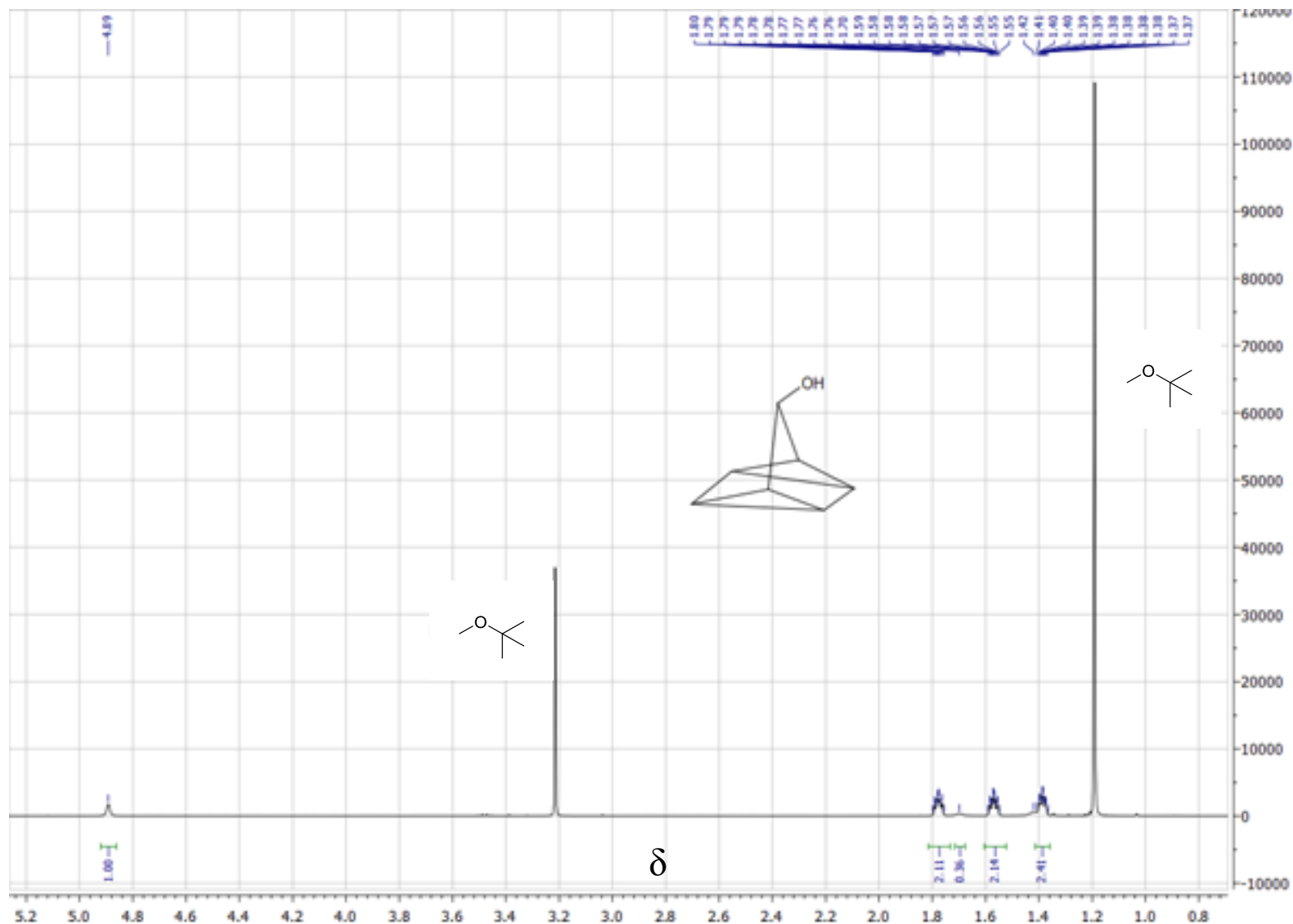


Synthesis of 7-Hydroxyquadricyclane



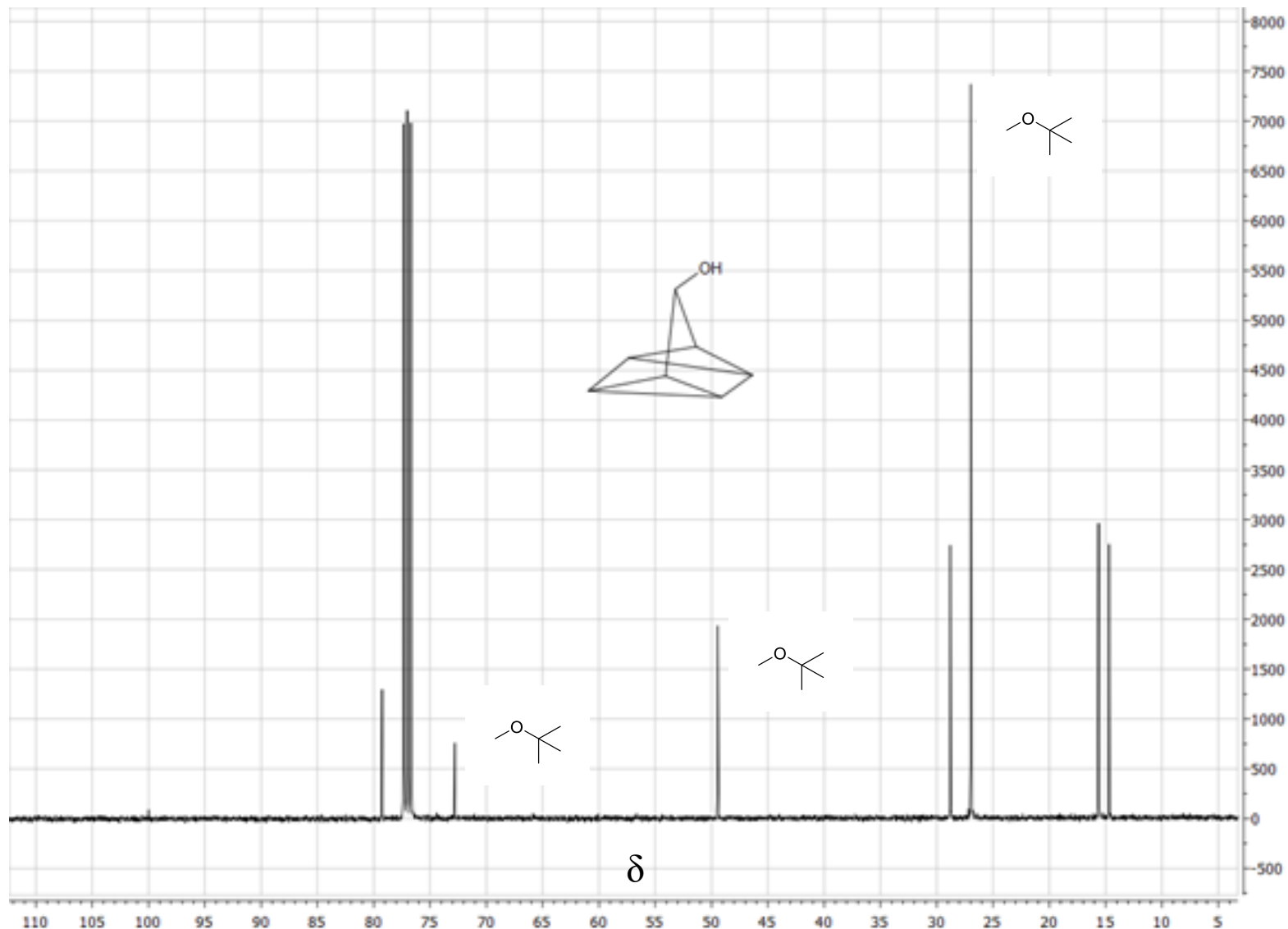
M. S. Schuurman, J. Giegerich, K. Pachner, D. Lang, B. Kiendl, R. J. MacDonell, A. Krueger, I. Fischer, *Chem.-Eur. J.* **2015**, *21*, 14486.
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Synthesis of 7-Hydroxyquadricyclane



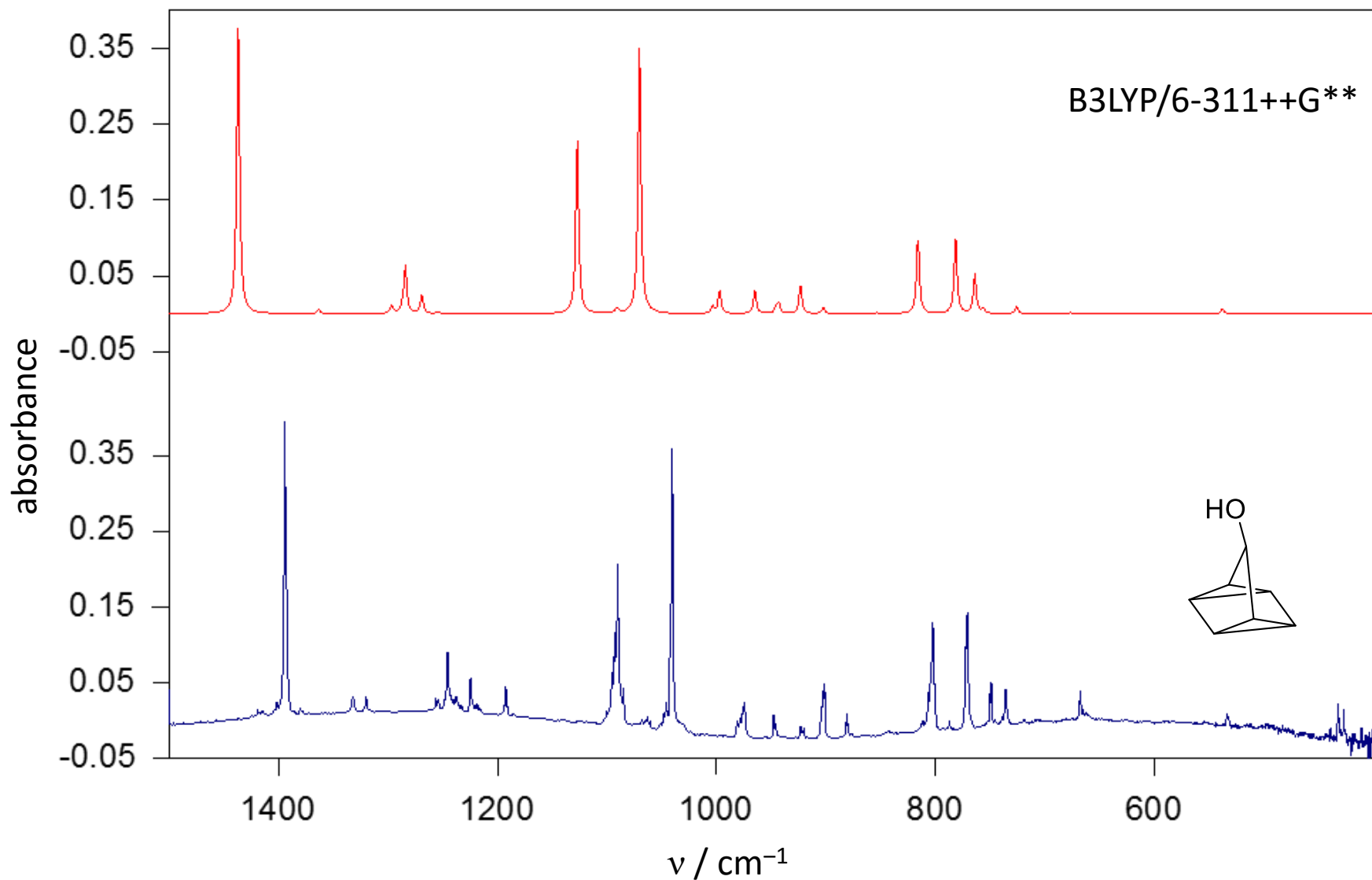
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Synthesis of 7-Hydroxyquadricyclane

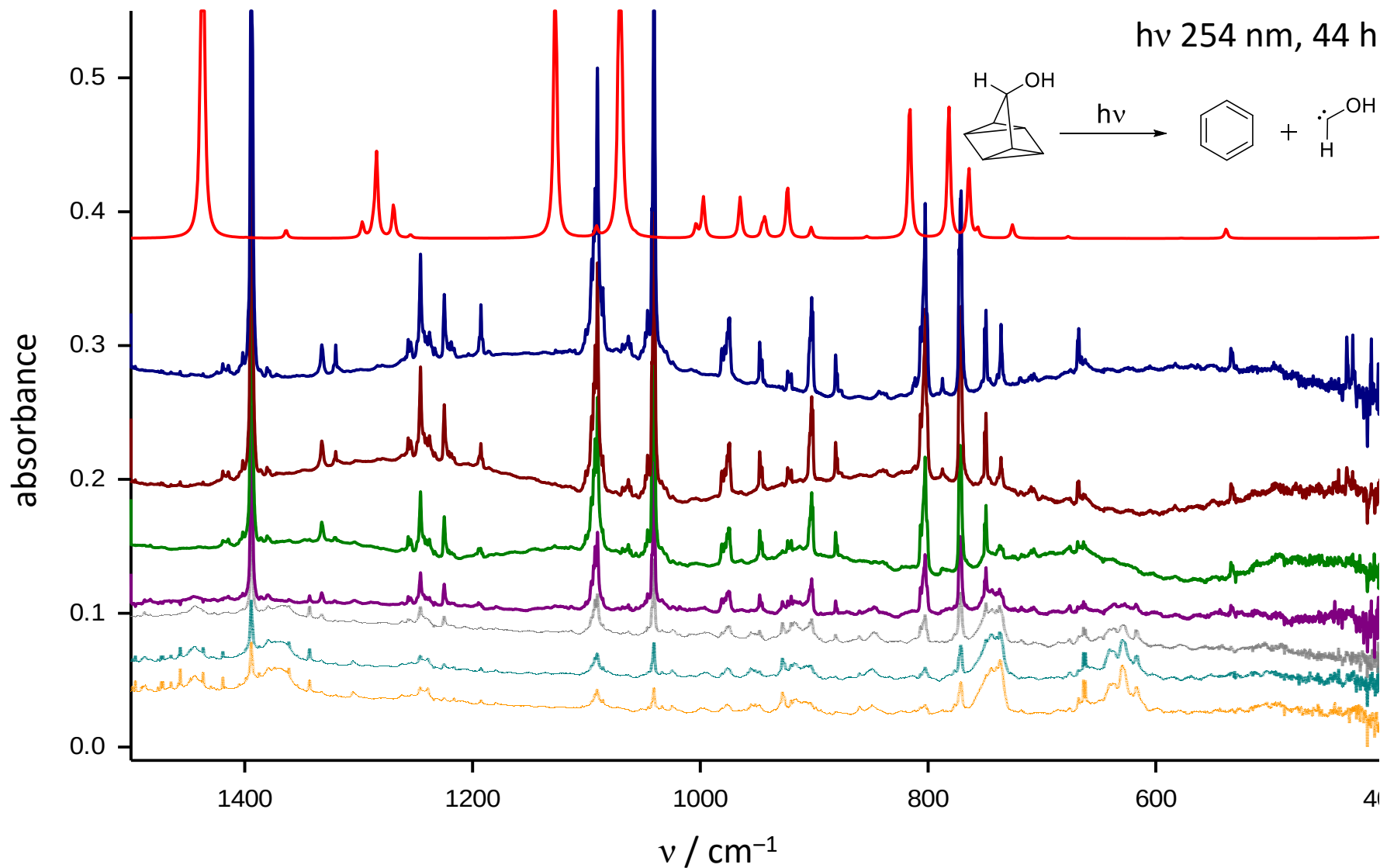


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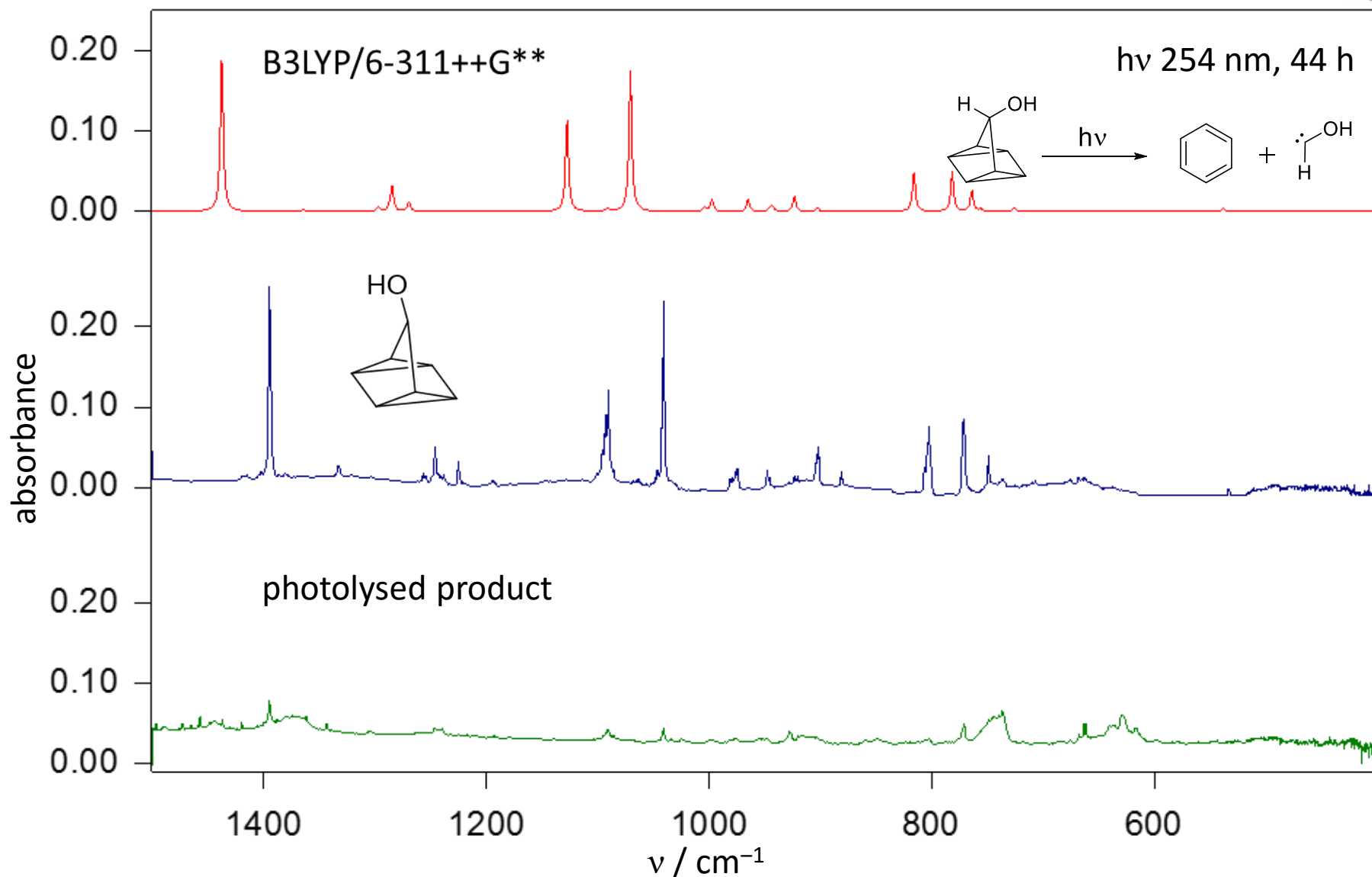
7-Hydroxyquadricyclane – Matrix-Isolation Studies



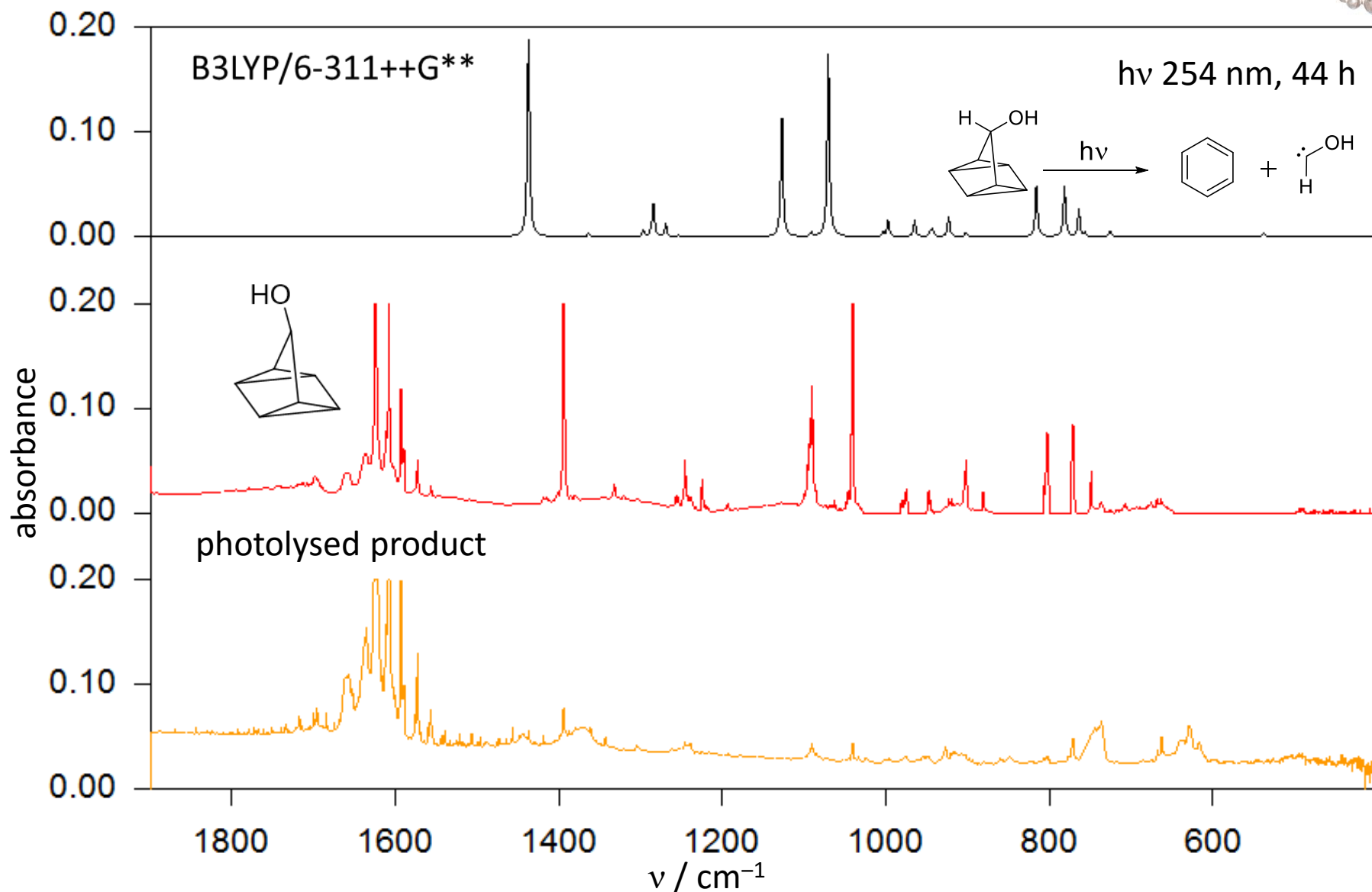
7-Hydroxyquadricyclane – Matrix-Isolation Studies



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7-Hydroxyquadricyclane – Matrix-Isolation Studies



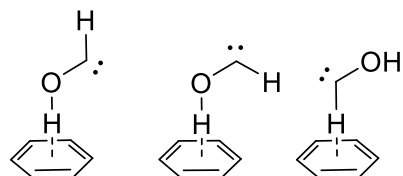


„intensity borrowing”

Outlook:

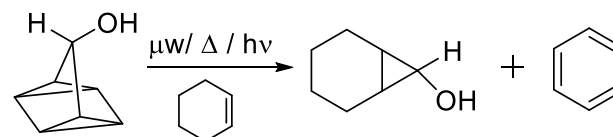
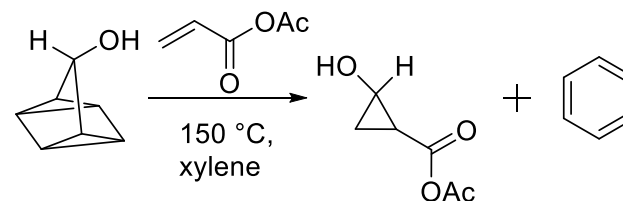
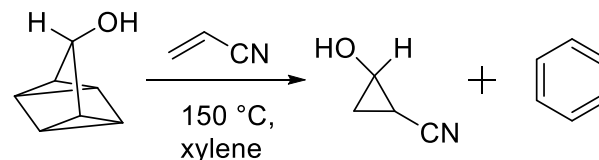
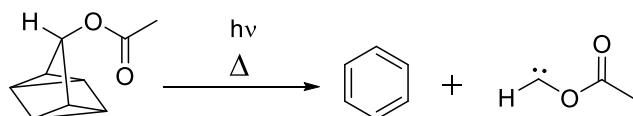


- „Intensity borrowing“
- Resynthesize 7-Hydroxyquadricyclane
- Synthesize Quadricyclanone and do some Grignard modifications
- Cyclopropanols



red shift $< 3500\text{ cm}^{-1}$

blue shift $> 3500\text{ cm}^{-1}$



Acknowledgement:

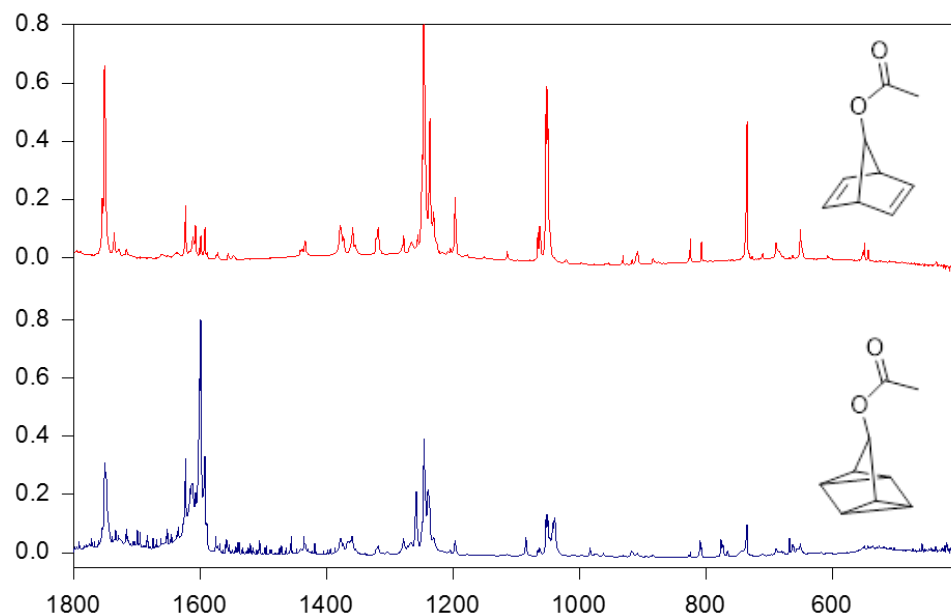
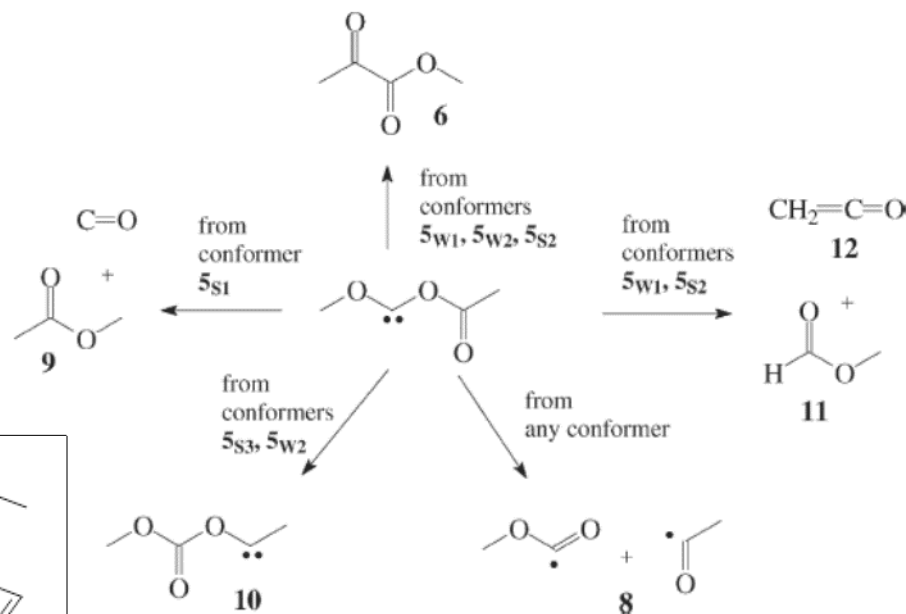
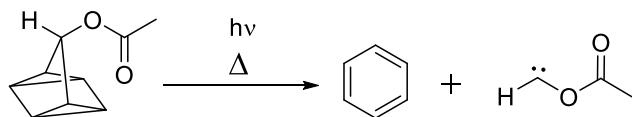


Thanks,...

- Professor Schreiner
- Dr. Dennis Gerbig
- Dr. Artur Mardyukov
- Cesare
- Group, analytic department...



7-Acetoxyquadricyclane – Matrix-Isolation Studies



W. Sokol, J. Warkentin *Can. J. Chem.* **2006**, 84 (7), 927. A. Klys, W. Czardybon, J. Warkentin *Can. J. Chem.* **2005**, 83 (9), 1360. W. Czardybon, J. Warkentin, N. H. Werstiuk *J. Phys. Org. Chem.* **2005**, 18 (6), 486.