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## **Upconverting nanovesicles for the activation of ruthenium anti-cancer prodrugs with red light**

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## Curriculum Vitae

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Sven Askes was born in Culemborg, The Netherlands on 31 May 1989. In 2007, he graduated from Christelijke Scholengemeenschap Walcheren High School in Middelburg. In 2010, he received his Bachelor of Science degree in Molecular Science and Technology of Leiden University and Technical University Delft. During the BSc program he visited Radford University (VA, USA) for a one-semester minor in business administration. His bachelor thesis was titled " *$\beta$ -enaminoketonato and  $\beta$ -diketiminato ligands and lanthanide (Eu, Tb) complexes thereof*". In 2012, he received his Master of Science degree *cum laude* in Chemistry with a specialization in "Science Based Business" at Leiden University. His scientific thesis was titled "*Luminescent properties of lanthanide coordination compounds with 2-hydroxy-isophthalate ligands*" and his business thesis was titled "*Working safely with production chemicals at Heineken International*". His scientific master thesis was awarded with the Unilever Research Prize in 2012.

In October 2012, he started his PhD research under supervision of Sylvestre Bonnet and Elisabeth Bouwman at the "Metals in Catalysis, Biomimetics and Inorganic Materials" (MCBIM) research group of the Leiden Institute of Chemistry, Leiden University. During his PhD studies, he collaborated with Prof. Dr. A. Kros (Leiden University), Prof. Dr. T. Schmidt (Leiden University), Dr. J. Kennis (Vrije University Amsterdam), Dr. Gilles Bruylants (Université Libre de Bruxelles), Dr. S. Wu (Max Planck Institute Mainz), Prof. Dr. B. Koster (Leiden University Medical Center), Prof. Dr. D. Heinrich (Leiden University), Prof. Dr. P. Bednarski (Universität Greifswald), Prof. Dr. A. Schiller (Friedrich-Schiller Universität Jena), Dr. S. Dembski (Fraunhofer Institute Würzburg), and Prof. J. van Hest (Radboud University Nijmegen). In total, he supervised two BSc and four MSc students during the PhD research, and he frequently supervised the first year practical courses. He was awarded with a poster prize at the International Symposium on the Photochemistry and Photophysics of Coordination Compounds (ISPPCC) in Krakow, Poland (2015), and he was nominated as Discoverer of the Year 2014 of the Faculty of Science, Leiden University. He presented the research described in this thesis at the following meetings and conferences:

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- NWO “Protein research, Nucleic acids and Lipids & Biomembranes” meeting, 2013 (Oral presentation)
- COST 1105 Whole Action Meeting in Zürich, Switzerland, 2014 (Oral presentation)
- Biomembranes meeting of Utrecht University, 2014 (Oral presentation)
- Cell Observatory Lecture, Leiden University, 2013 (Oral presentation)
- Chemical Biology Lecture, Leiden University, 2015 (Oral presentation)
- International Symposium on the Photochemistry and Photophysics of Coordination Compounds, Kraków, Poland, 2015 (Poster)
- Holland Research School of Molecular Chemistry (HRSMC) Symposium 2014 (Poster)
- CHAINS 2014 and 2015 (Poster)
- Reedijk symposium 2014 (Poster)

During the PhD research, he participated in the following courses:

- HRSMC Physical Methods in Inorganic Chemistry
- HRSMC Photophysics, Photochemistry, and Photobiology
- Metals and Life (Leiden University)
- Spin and Photochemistry (Leiden University)
- Graduate School courses of Leiden University: “Time management”, “On being a scientist”, “Communication in Science”, “Effective Communication”, and “Negotiation”

## List of publications

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J. H. Adriaanse, **S. H. C. Askes**, Y. van Bree, S. van Oudheusden, E. D. van den Bos, E. Günay, I. Mutikainen, U. Turpeinen, G. A. van Albeda, J. G. Haasnoot, J. Reedijk. "Coordination chemistry of 5,6,7-trimethyl-[1,2,4]triazolo[1,5-*a*]pyrimidine with first-row transition-metal salts: Synthesis, spectroscopy and single-crystal structures, with counter-anion dependence of the structures." Polyhedron, **2009**, 28, 3143

**S. H. C. Askes**, A. Bahreman, and S. Bonnet. "Activation of a Photodissociative Ruthenium Complex by Triplet–Triplet Annihilation Upconversion in Liposomes." Angew. Chem., Int. Ed., **2014**, 53, 1029.

**S. H. C. Askes** and S. Bonnet. "Upconverting Vesicles and Uses" International Patent Application, **2015**, WO/2015/059180.

**S. H. C. Askes**, N. López Mora, R. Harkes, R. I. Koning, B. Koster, T. Schmidt, A. Kros, and S. Bonnet. "Imaging the lipid bilayer of giant unilamellar vesicles using red-to-blue light upconversion." Chem. Commun., **2015**, 51, 9137.

**S. H. C. Askes**, M. Kloz, G. Bruylants, J. T. Kennis, and S. Bonnet. "Triplet-triplet annihilation upconversion followed by FRET for the red light activation of a photodissociative ruthenium complex in liposomes." Phys. Chem. Chem. Phys., **2015**, 17, 27380.

X. Liu, S. Akerboom, **S. H. C. Askes**, I. Mutikainen, and E. Bouwman. "A novel coordination network of Tb(III) with 2-hydroxy-trimesic acid showing very intense photoluminescence." Inorg. Chem. Commun., **2015**, 61, 60.

L. Kong, **S. H. C. Askes**, S. Bonnet, A. Kros, and F. Campbell. (2016). "Temporal Control of Membrane Fusion through Photolabile PEGylation of Liposome Membranes." Angew. Chem., Int. Ed., **2016**, 55, 1396.

S. L. Hopkins, B. Siewert, **S. H. C. Askes**, P. van Veldhuizen, R. Zwier, M. Heger, and S. Bonnet. "In vitro cell irradiation protocol for testing photopharmaceuticals and the effect of blue, green, and red light on human cancer cell lines." Photochem. Photobiol. Sci., **2016**, 15, 644.

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V. H. S. van Rixel, B. Siewert, S. L. Hopkins, **S. H. C. Askes**, A. Busemann, M. A. Siegler, and S. Bonnet. "Green light-induced apoptosis in cancer cells by a tetrapyrridyl ruthenium prodrug offering two trans coordination sites." *Chem. Sci.*, **2016**, 7, 4922.

J. A. Göttle, F. Alary, M. Boggio-Pasqua, I. M. Dixon, J.-L. Heully, A. Bahreman, **S. H. C. Askes**, and S. Bonnet. "Pivotal Role of a Pentacoordinate 3MC State on the Photocleavage Efficiency of a Thioether Ligand in Ruthenium(II) Complexes: A Theoretical Mechanistic Study." *Inorg. Chem.*, **2016**, 55, 4448.

**S. H. C. Askes**, W. Pomp, S. L. Hopkins, A. Kros, S. Wu, T. Schmidt, and S. Bonnet. "Imaging upconverting polymersomes in cancer cells: biocompatible anti-oxidants brighten triplet-triplet annihilation upconversion." *Small*, **2016**, DOI: 10.1002/smll.201601708.

L. N. Lameijer, S. L. Hopkins, T. G. Brevé, **S. H. C. Askes**, and S. Bonnet. "L-versus D-glucose conjugation: Mitochondrial targeting of a light-activated dual-mode of action ruthenium-based anticancer prodrug." *Chem. Eur. J.*, **2016**, in press.

**S. H. C. Askes**, P. Brodie, G. Bruylants, and S. Bonnet. "Temperature dependence of triplet-triplet annihilation upconversion in phospholipid membranes." **2016**, to be submitted.

**S. H. C. Askes**, M. S. Meijer, T. Bouwens, I. Landman, and S. Bonnet. "Photochemical activation of Ru(II) polypyridyl prodrugs through meat using triplet-triplet annihilation upconversion." **2016**, to be submitted.

**S. H. C. Askes**, V. Leeuwenburgh, W. Pomp, S. Grecea, T. Schmidt, and S. Bonnet. "Silica-coating of upconverting liposomes for protection against quenching by oxygen." **2016**, to be submitted.

**S. H. C. Askes**, M. S. Meijer, L. N. Lameijer, and S. Bonnet. "Escape of membrane-anchored chromophores from liposomes." **2016**, to be submitted.

**S. H. C. Askes**, and S. Bonnet. "Light upconversion using triplet-triplet annihilation for application in biology." **2016**, to be submitted.

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