Spider silk for controlled drug delivery

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Outstanding properties of spider silks are well known for thousands of years

» high tensile strength
» high elasticity
» no inflammation
» no allergic response
Possible applications for silk-based materials

- vascular wound repair devices
- haemostatic dressings and sutures
- drug delivery systems
- cosmetical products
- technical textiles / protective clothing
- surface / fiber coatings
- etc., etc., etc.
Silk proteins are suitable for drug delivery...

Hardy et al., Polymer 2008, 49, 4309
Employing silk proteins for applications

Problems:
- Availability of the natural proteins (e.g., cannibalism of spiders)
- Organization of genes

Solution:
- Analysis of protein components
- Reverse translation and gene - design for modern biotechnology

Huemmerich et al., Biochemistry 2004, 43, 13604
Vendrely and Scheibel, Macromol. Biosci. 2007, 7, 401
Spider silk – a diverse biopolymer

Major Ampullate Silk
structural and drag line silk

Flagelliform Silk
capture spiral threads

Minor Ampullate Silk
auxiliary spiral thread

Piriform Silk
attachment cement

Cylindrical Silk
tough outer egg case

Aciniform Silk
soft inner egg and wrapping

Aggregate Silk
aqueous sticky coating

Roemer & Scheibel, in: Fibrous Proteins, Landis Bioscience 2008, 121
Heim et al., Angew. Chem. Int. ed. 2009, 48, 2
Microcapsules made of biotech silk

Hardy et al., *Polymer* 2008, 49, 4309
Microcapsules made of biotech silk

Hermannson et al., Adv. Mater. 2007, 19, 1810
Hermannson et al., Phys. Chem. Chem. Phys. 2007, 9, 6442
Microcapsules made of biotech silk

Young's modulus: 0.7 – 3.6 GPa
chemically stable: 2% SDS, 8M urea


Weidenauer & Scheibel, *Deutsche Apothekerzeitung* 2008, 148, 3152
Microcapsules made of biotech silk

Membrane thickness is between 50 and 70nm.

Hermannson et al, Adv. Mater. 2007, 19, 1810
Microcapsules can encapsulate large molecules

Permeability of polydisperse FITC-labeled dextran

Hermannson et al, Phys. Chem. Chem. Phys. 2007, 9, 6442
Controlled release of encapsulate

Release is triggered by the addition of Proteinase K

Hermannson et al, Adv. Mater. 2007, 19, 1810
Silk microspheres for small encapsulates
Phase separation reveals silk microspheres

self-assembly: slow (>2h)  salting out: fast (<5s)

Slotta et al., Angew. Chem. Int. Ed. 2008, 47, 4592
Control of particle size

mixing intensity

protein concentration

Lammel et al, ChemSusChem. 2008, 1, 413
Drug encapsulation in silk microspheres

Spider silk microspheres can be used for encapsulating poorly water-soluble substances.

Salting out of silk

Drug encapsulation in silk microspheres

blank

loaded with β-carotene

Liebmann et al., Colloids and Surfaces A: Physicochem. Eng. Aspects, 2008, 331, 126
Drug encapsulation in silk microspheres

\(\beta\)-carotene release in intestinal fluids

no \(\beta\)-carotene release in gastric fluids

in collaboration with


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Acknowledgement

**former Lab members**
Christian Ackerschott
Simone Hess
Daniel Hümmrich
Lin Römer
Sayam SenGupta
Charlotte Vendrely

**TUM**
Horst Kessler
Andreas Bausch

**LMU**
Gerhard Winter

**Martin-Luther-Universität Halle**
Rainer Rudolph

**Universität Sussex, UK**
Louise Serpell

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...to new Products

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