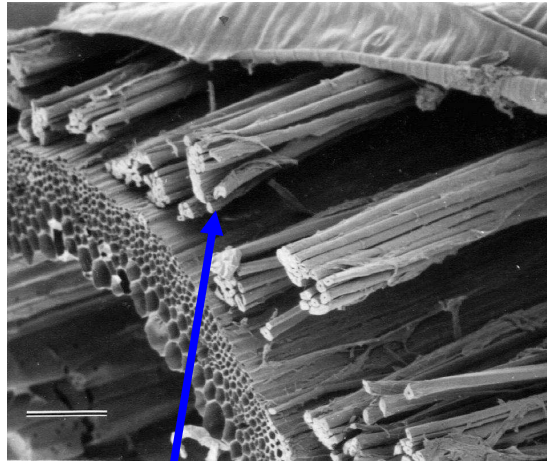
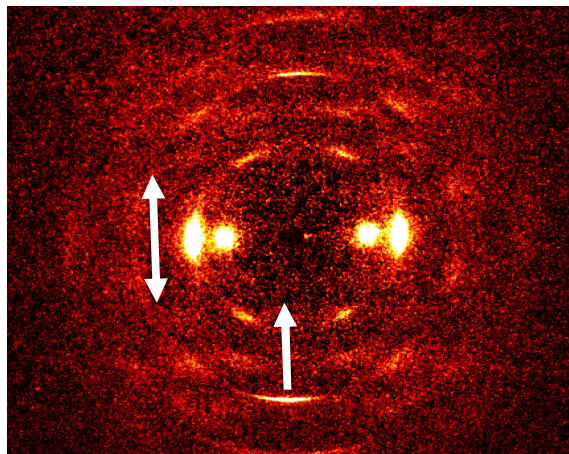


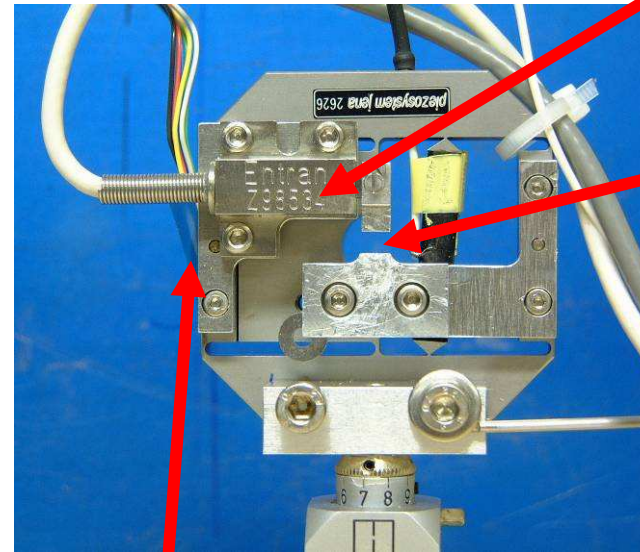
Mikroskopische *in situ* Streckexperimente



Flachfasern:
hochorientierte Zellulose



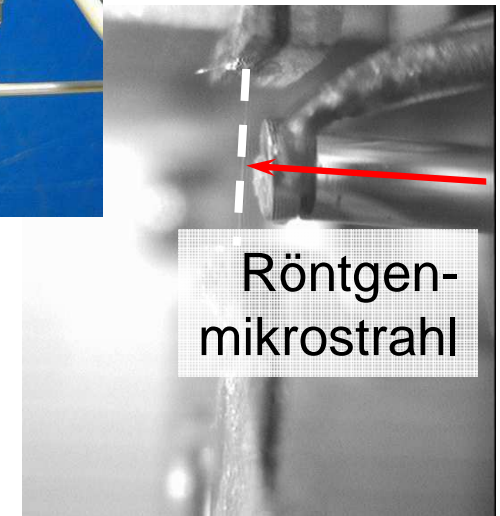
Piezo-Streckzelle für
in situ Röntgenstreuung an
Einzelfasern



Dehnungs-
meßstreifen

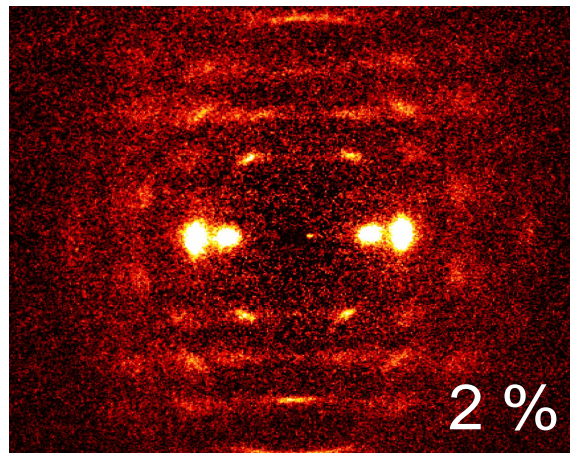
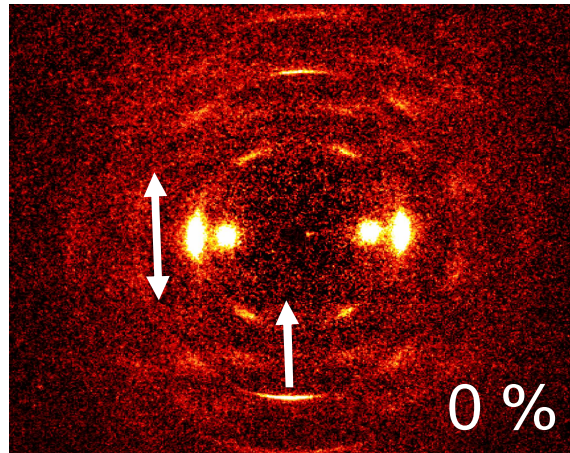
Kraftsensor

Faser

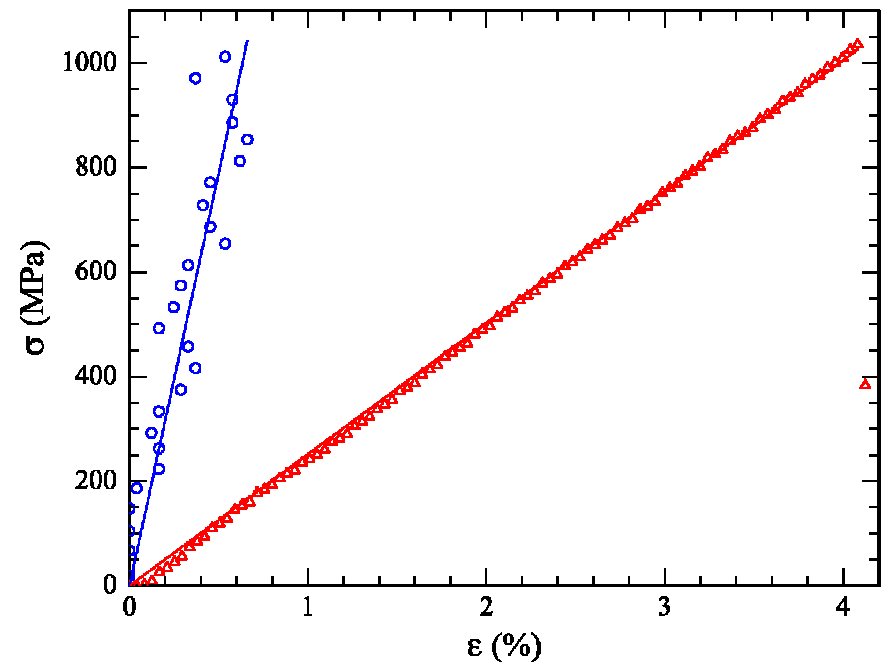
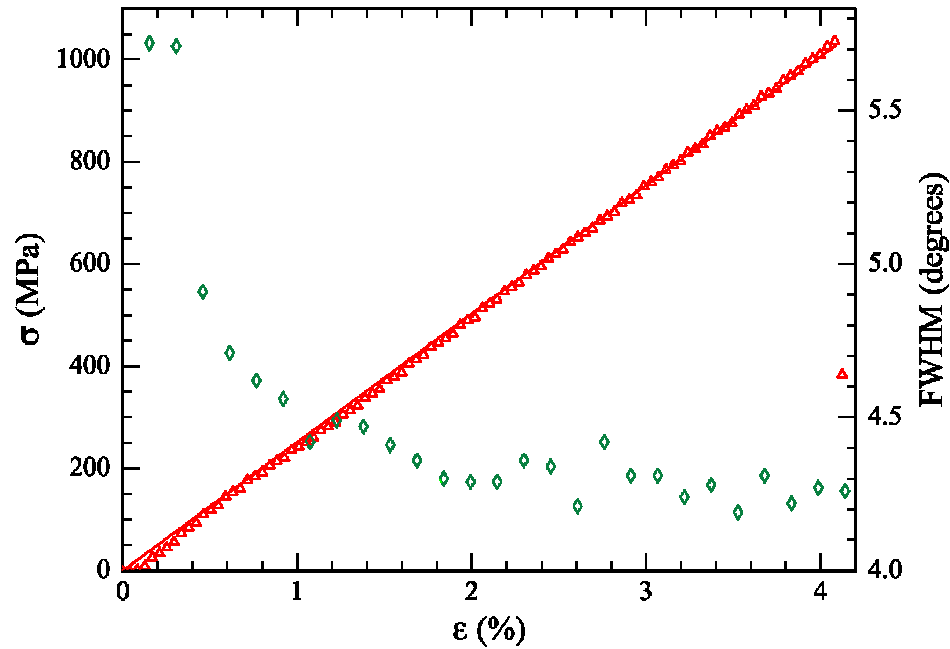


Röntgen-
mikrostrahl

Streckexperimente an einzelnen Flachfasern

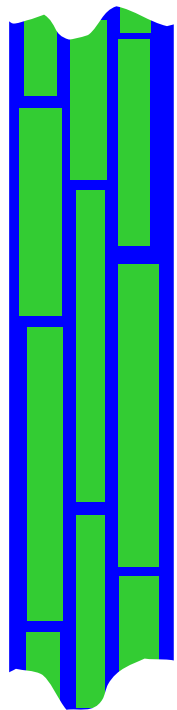


0.067 % / s
2 s pro Bild



K. Kölln, J. Keckes, S. V. Roth,
M. Burghammer, M. Müller.
03/2002 (unveröffentlicht)

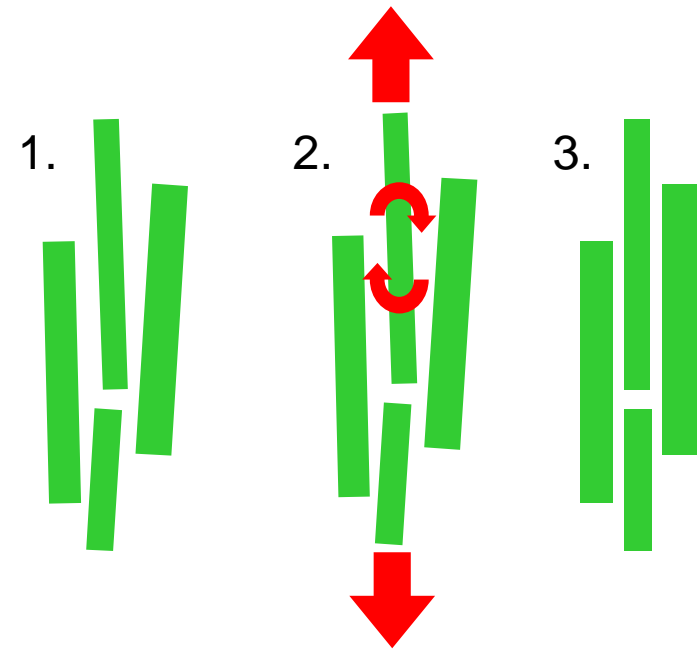
Die Zellulosefaser als Nanokomposit



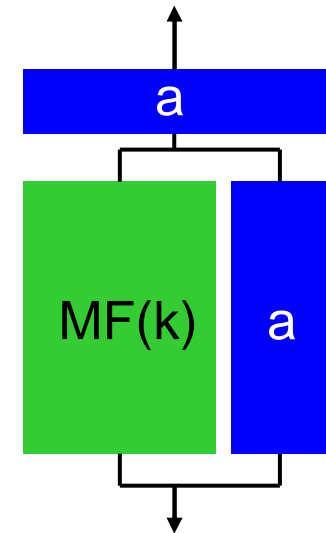
kristalline Mikrofibrillen
eingebettet in
amorphe Matrix

Hemicellulose (Polysaccharide)
evtl. + Lignin = Verholzen

Rotation
der Mikrofibrillen



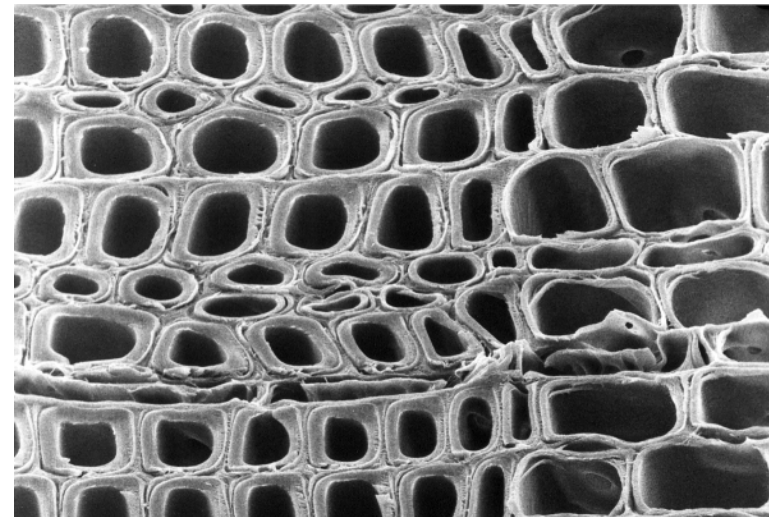
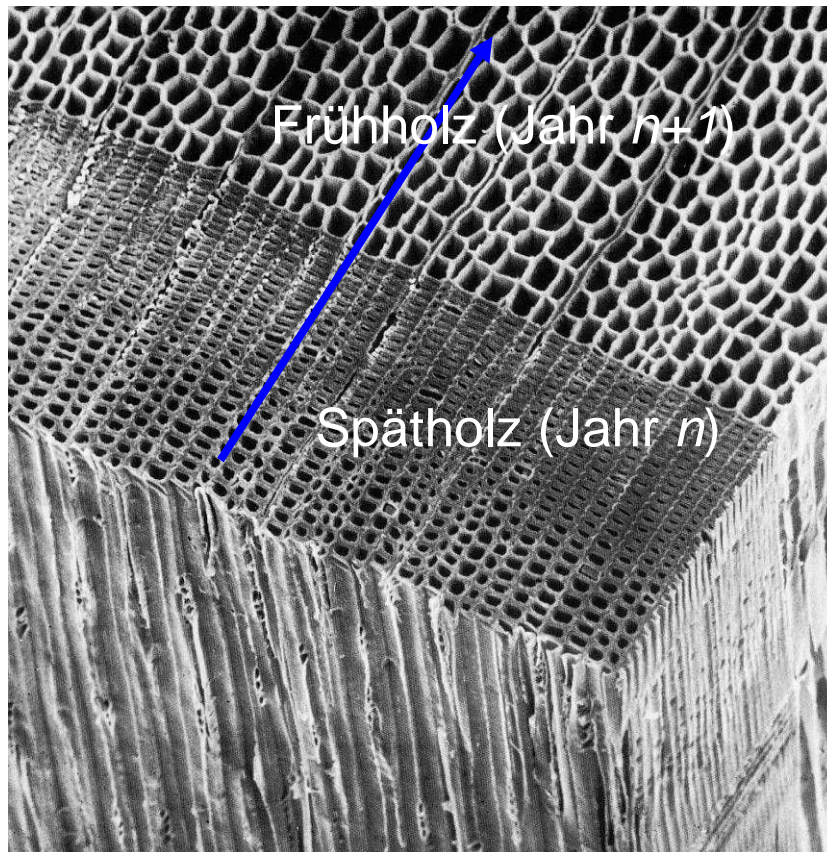
Dehnung
der Mikrofibrillen



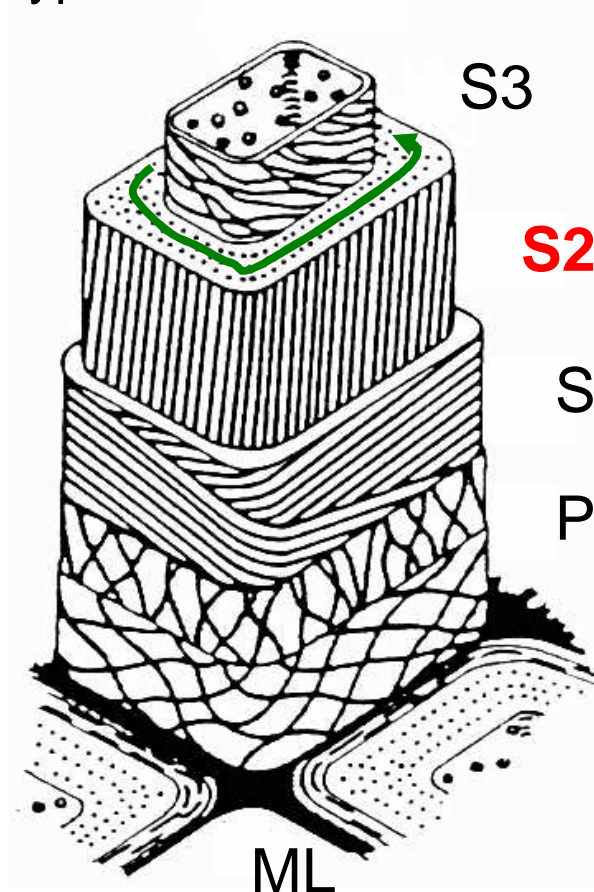
2.1.4 Mikro- und Nanostruktur von Holz

makroskopisch \Rightarrow mikroskopisch: **Jahrringe**

Dichtevariation: - **Frühholz:** große Zellen, dünne Wände
- **Spätholz:** kleine Zellen, dicke Wände



typische Nadelholzzelle



Zellwand ist in *Schichten* gegliedert:

ML: **Mittellamelle**, reich an Lignin

P: **primäre Zellwand**, schlecht kristalline Zellulose, keine Vorzugsorientierung

S1, S2, S3: **sekundäre Zellwand**, orientierte Zellulose, lignifiziert

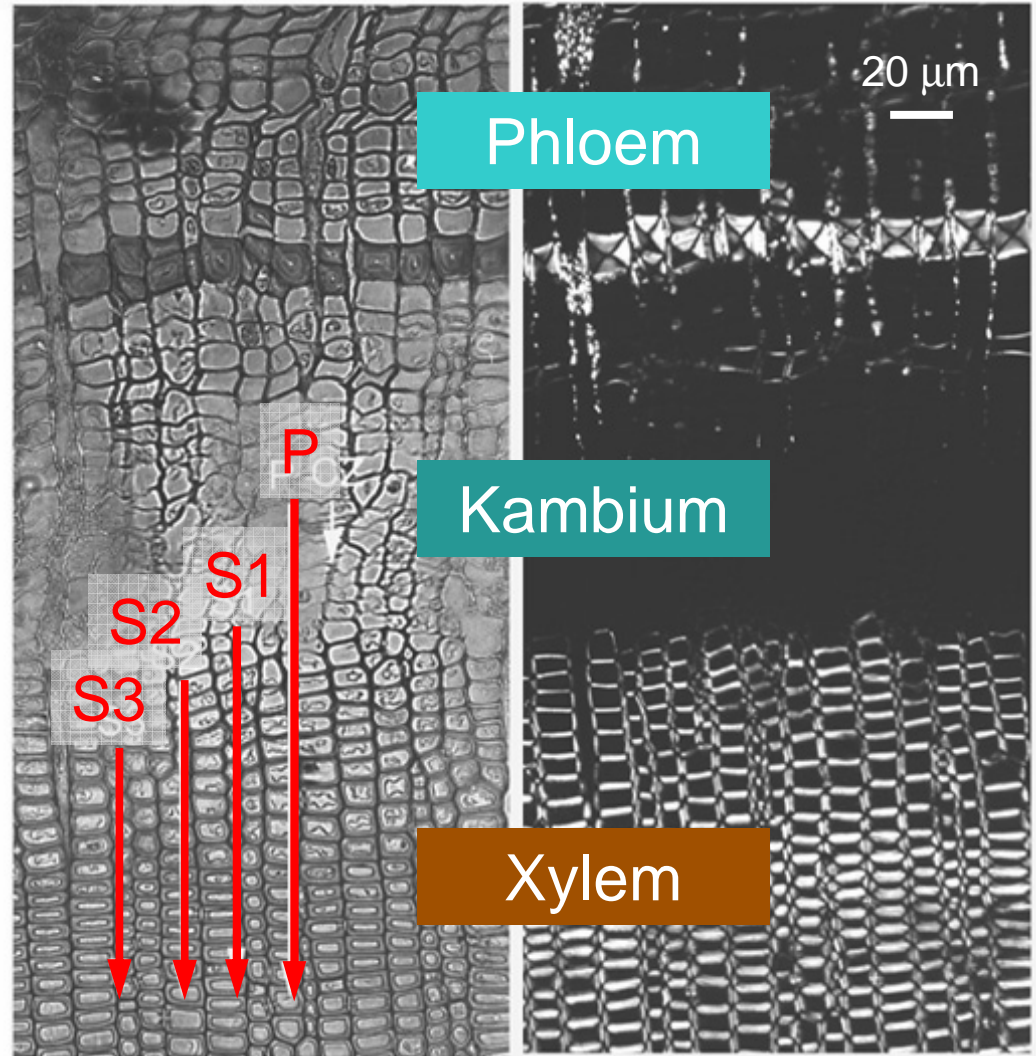
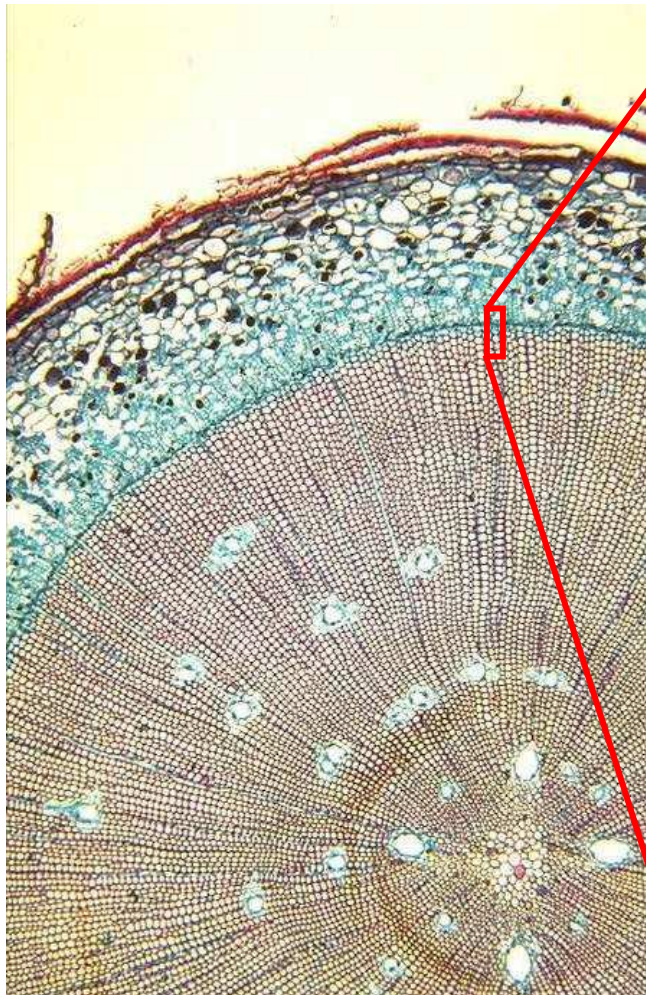
- **helikale** Struktur
- unterschiedlicher Steigungswinkel in S1-S3
- >80% der Dicke **S2**

Entstehung der Schichten beim **sekundären Dickenwachstum**

Wachstumszone: Cambium zwischen Rinde (Phloem) und Kern (Xylem, Tracheiden)

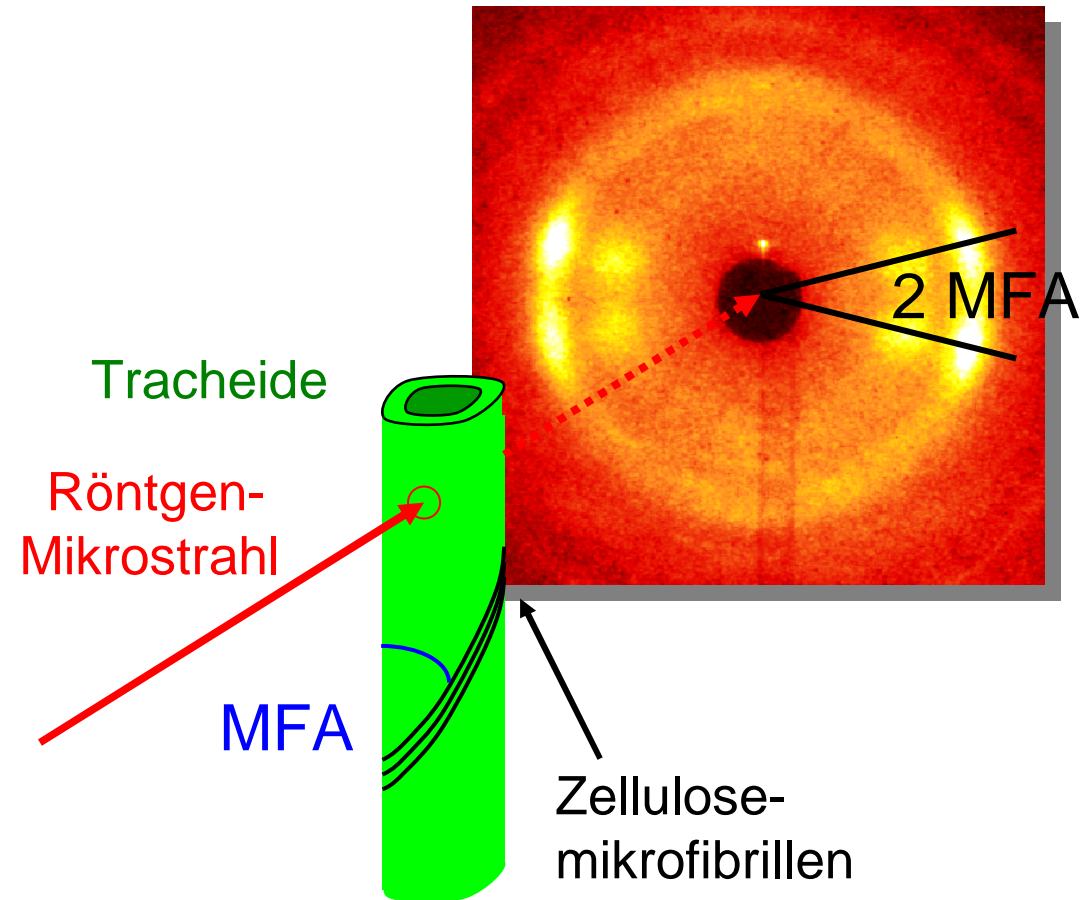
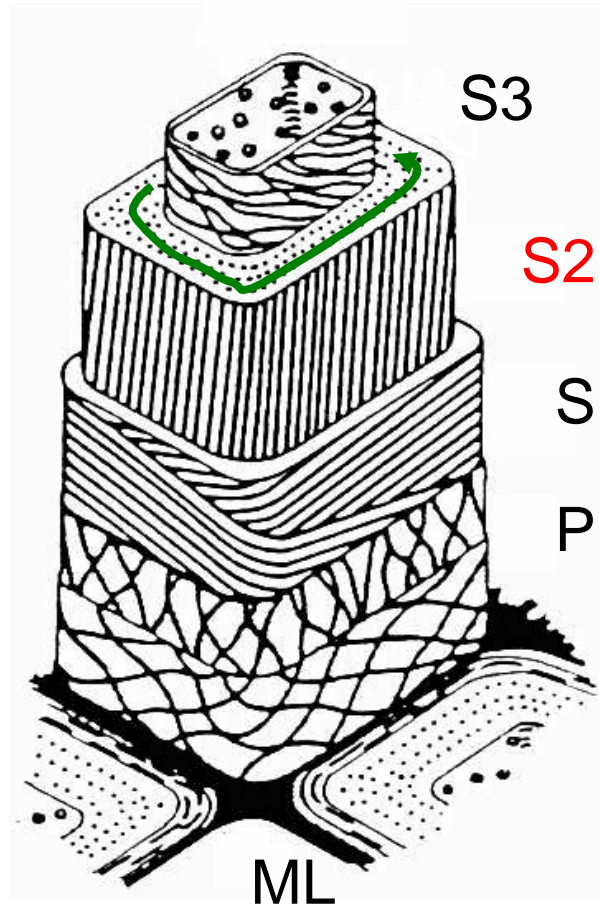
Sekundäres Dickenwachstum: Differenzierung von Holzzellen 82

Der Baum wächst außen (unter der Rinde)



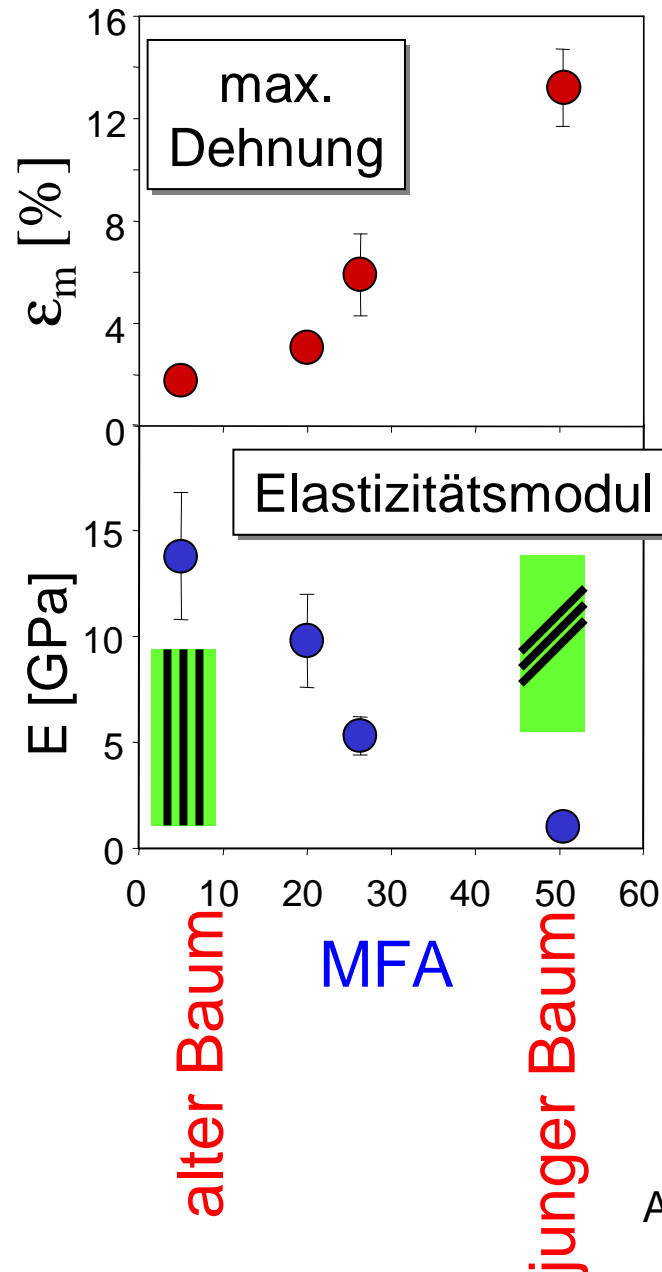
optische Mikroskopie
in normalem und polarisiertem Licht

Röntgenstreuung an Nadelholzzellen (Tracheiden)



Mikrofibrillenwinkel (MFA)
= 90° – Steigungswinkel der Helix

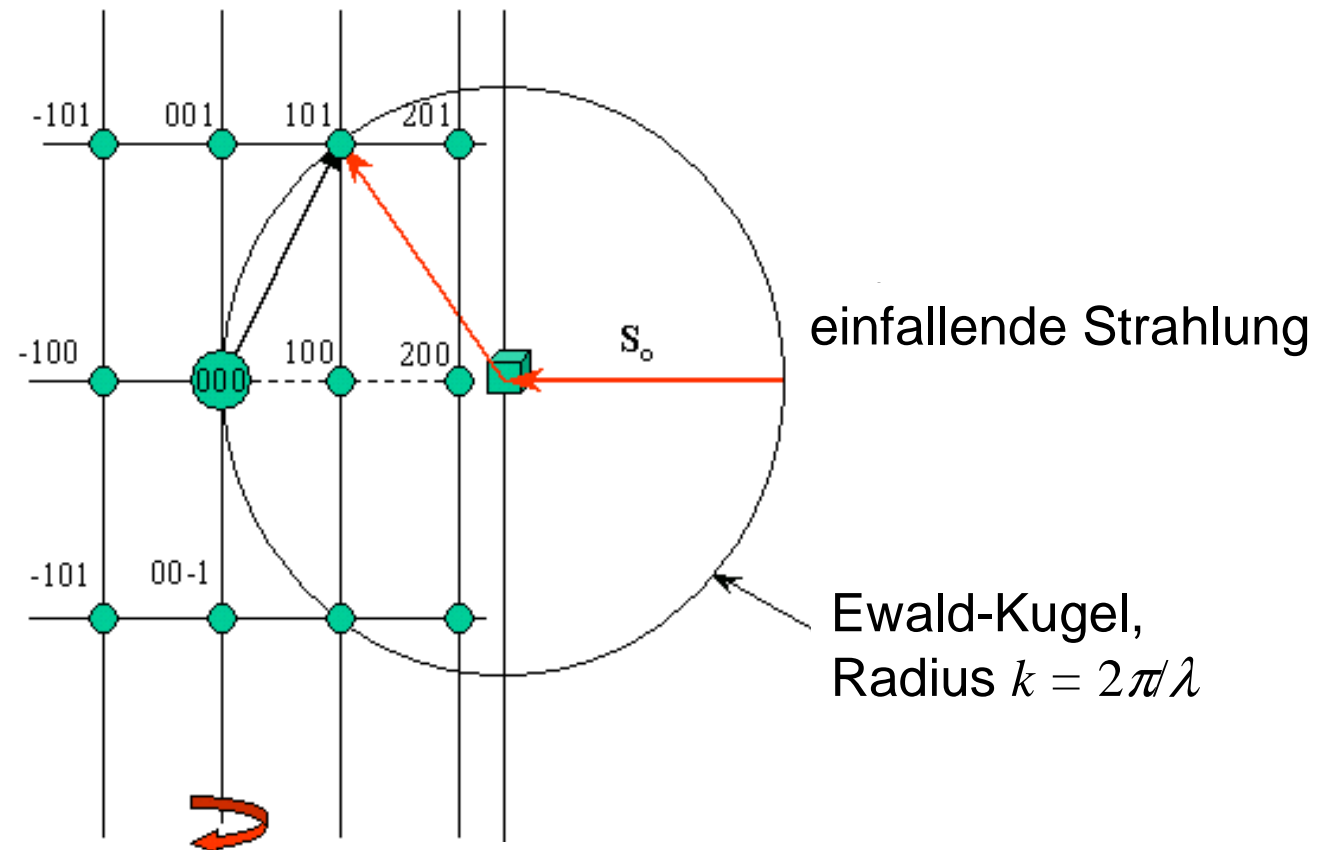
Mechanische Optimierung von Bäumen



Wiederholung: Ewald-Konstruktion

Formulierung der Beugungsbedingung:

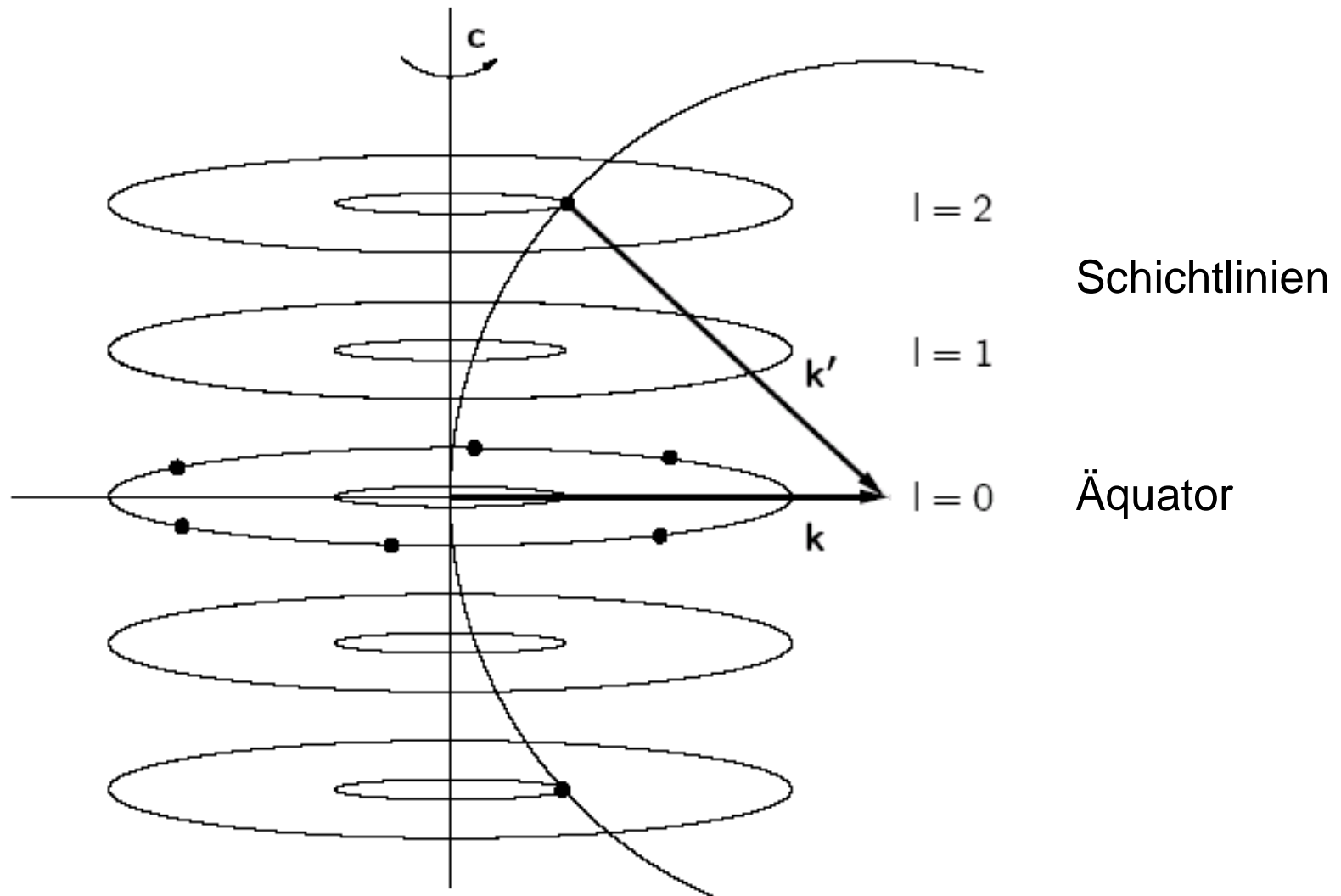
Wellenvektorübertrag \mathbf{Q} = reziproker Gittervektor \mathbf{G}



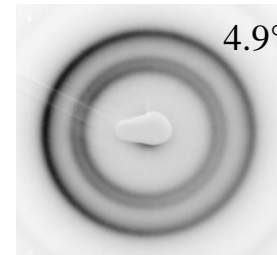
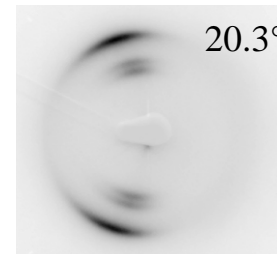
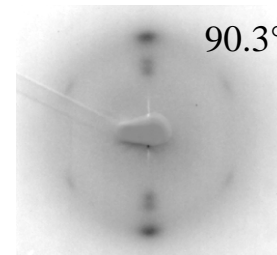
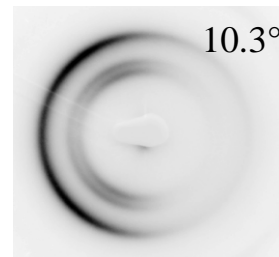
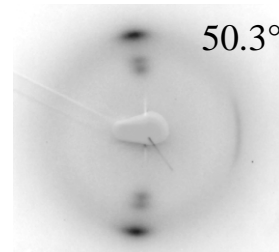
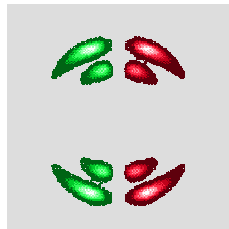
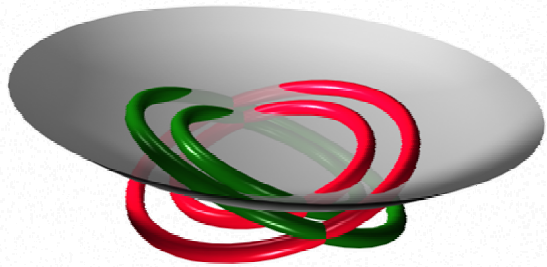
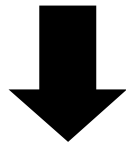
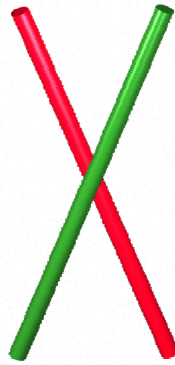
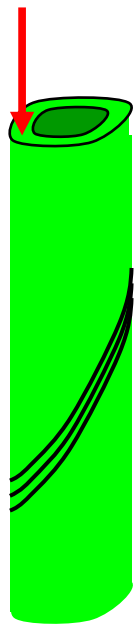
Drehkristallaufnahme
= Fasertextur

Ewald-Konstruktion für Fasertextur

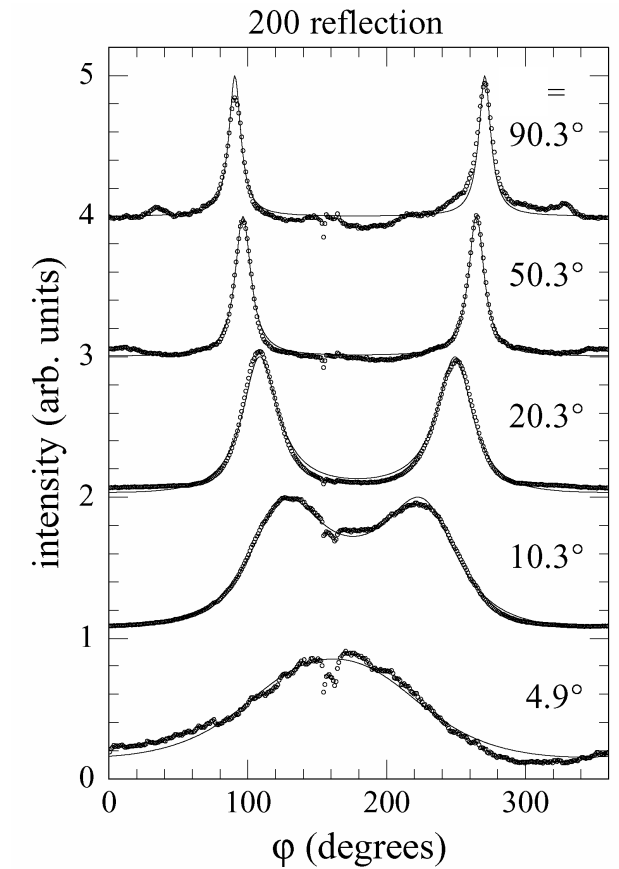
Drehachse = Faserachse (ausgezeichnet)



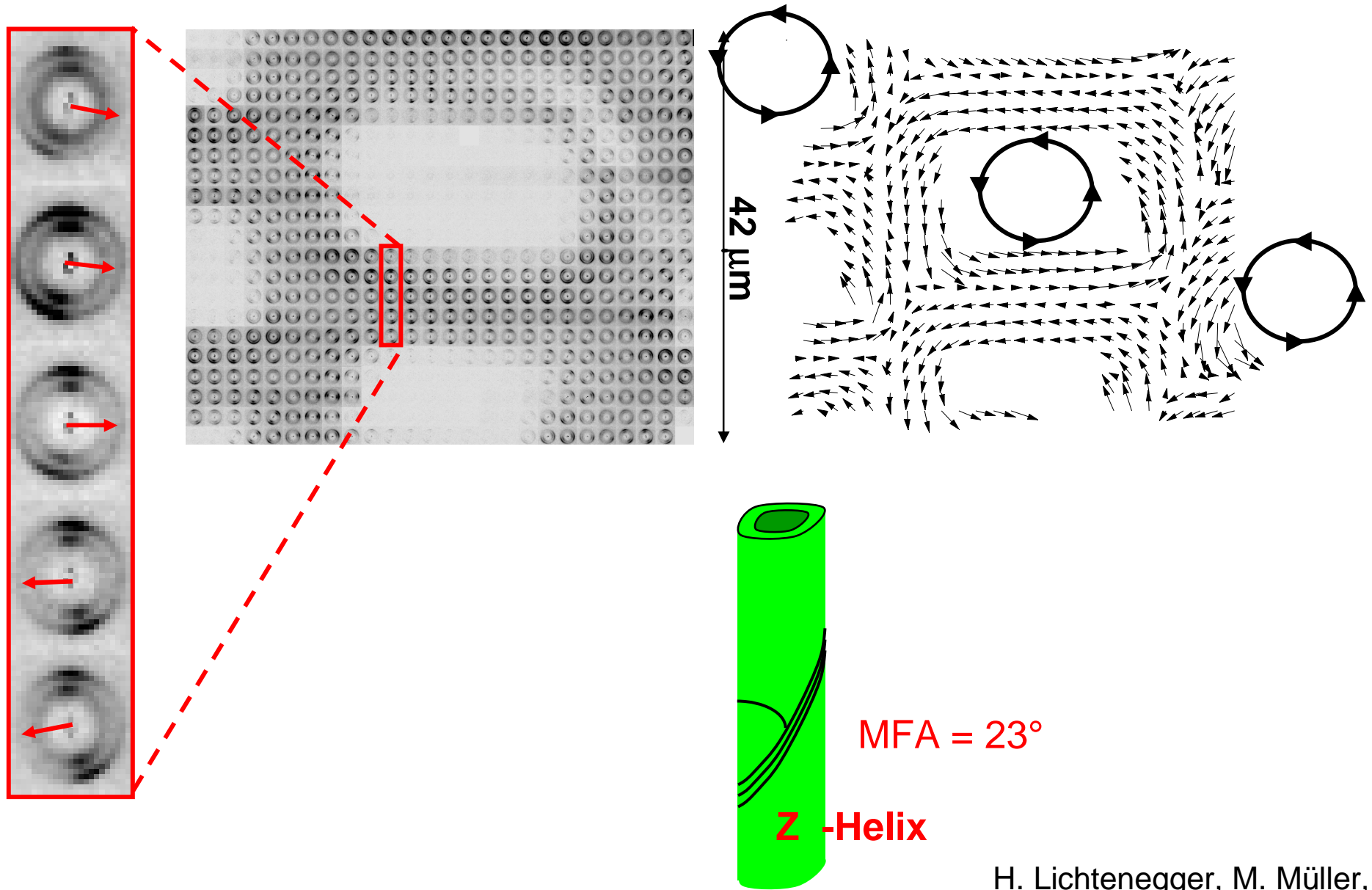
Faser-Streugeometrie bei gekippten Fasern (gegen den Strahl)



Azimuthale Scans



Zellulose-Orientierung in Holz-Zellwänden



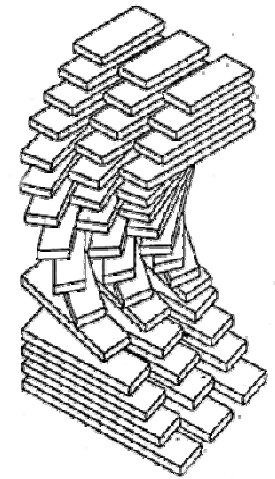
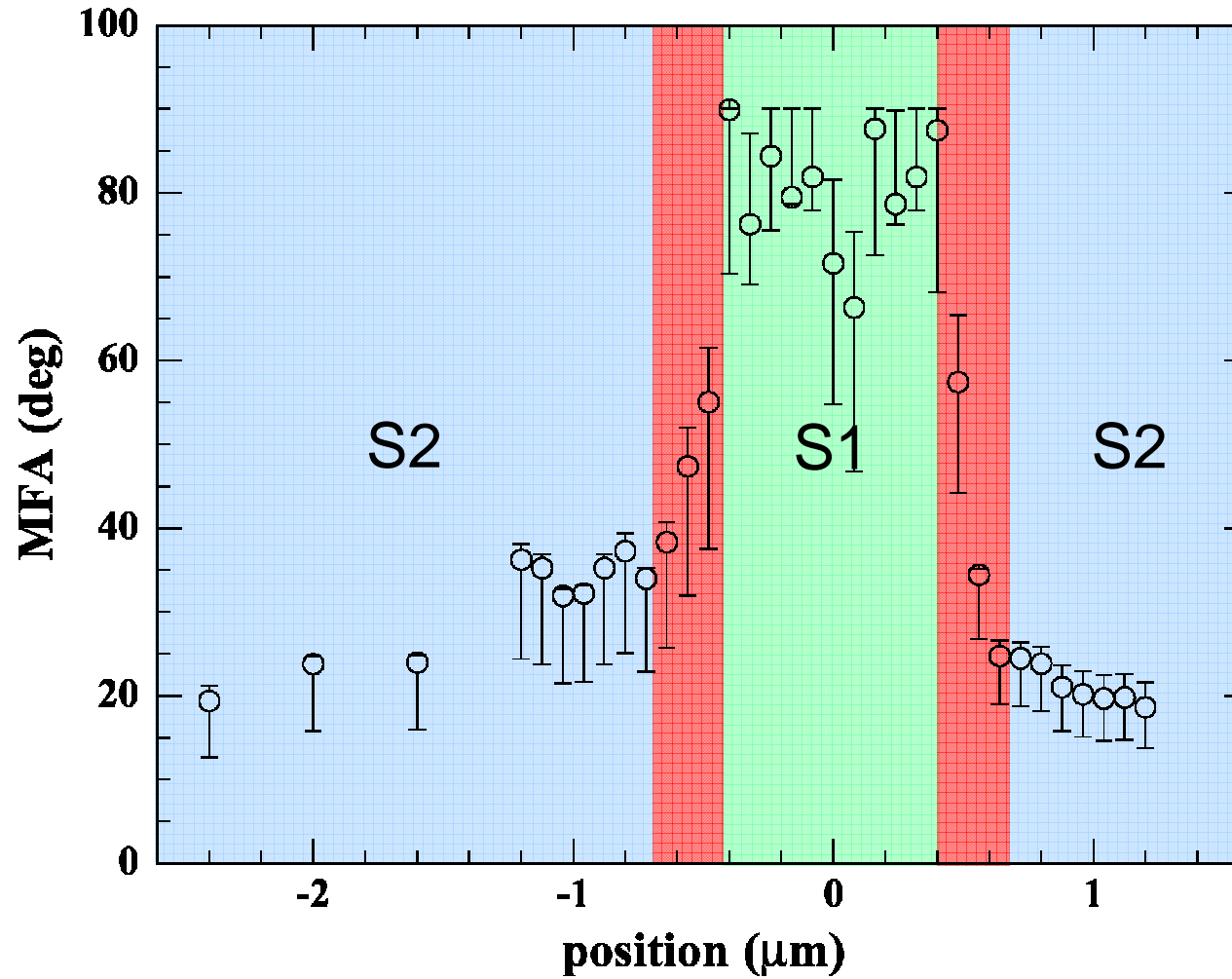
H. Lichtenegger, M. Müller,
O. Paris, C. Riekkel, P. Fratzl
J. Appl. Cryst. **32**, 1127-1133 (1999)

MFA: The Movie

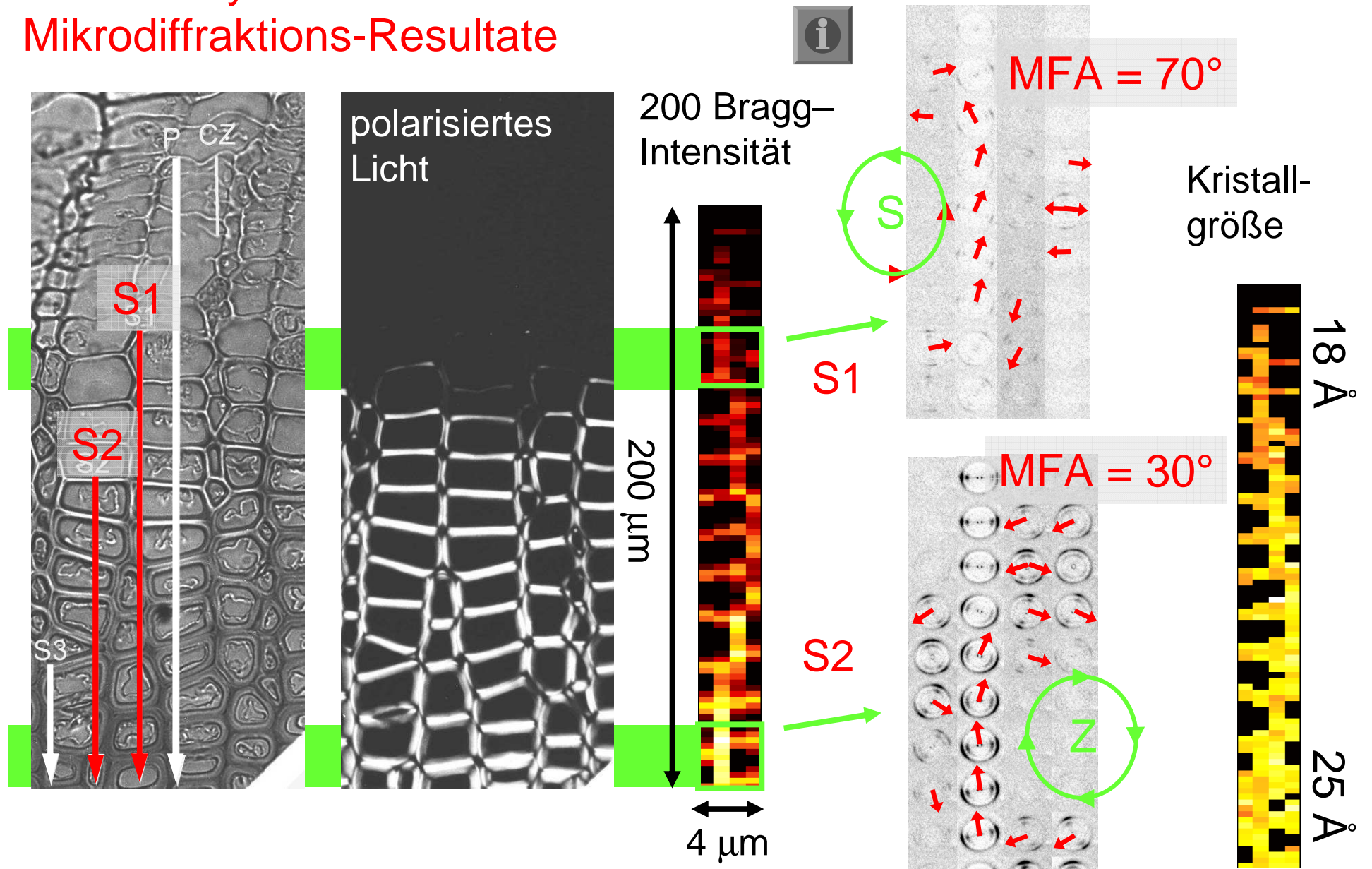




Sub-Mikrometer-Ortsauflösung: Helikoidaler Übergang zwischen S1 und S2?



Zellwandsynthese in der Wachstumszone: Mikrodiffractions-Resultate



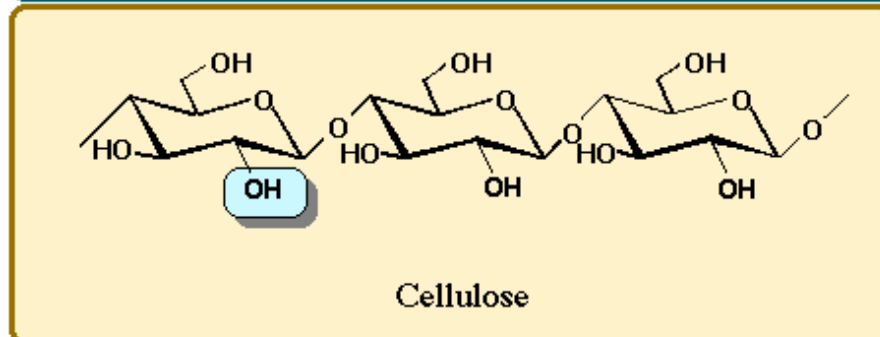
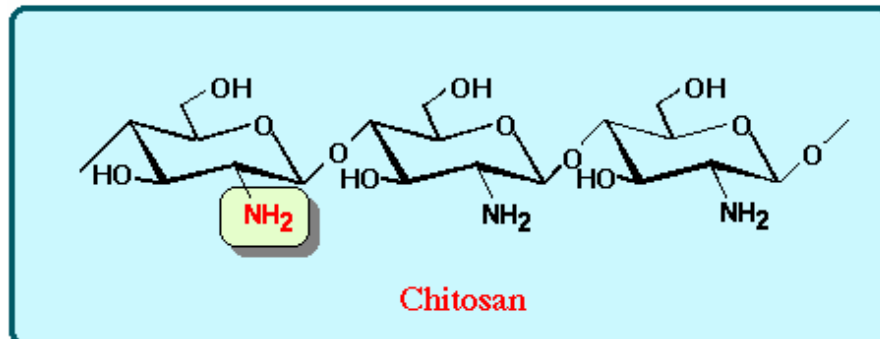
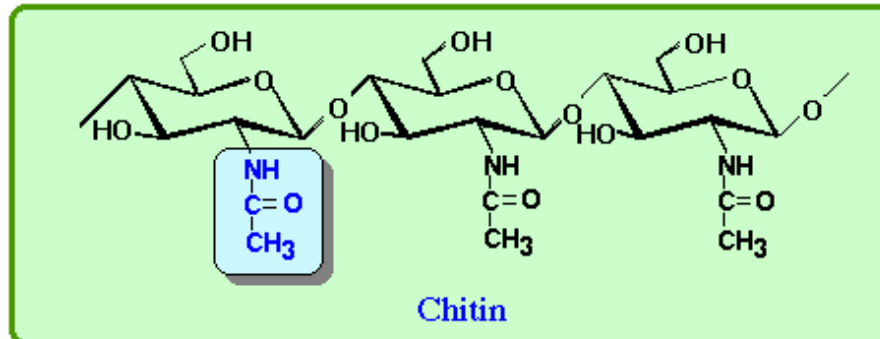
M. Müller R. Hori, T. Itoh, J. Sugiyama
Biomacromolecules **3**, 182-186 (2002)

2.2 Chitin und Chitosan

- **Chitin:** Biomaterial der Außenskelette von Gliederfüßern
- chemisch eng verwandt mit Zellulose;
auch 2 kristalline Phasen:
 - α antiparallele Ketten (tritt in der Natur auf)
 - β parallele Ketten
- **Chitosan:** chemisch modifiziertes Chitin
- *Anwendungen:* Schlankheitspillen, Filter, Arzneimitteldosierung, Fotopapier, Membranen, ...



Verwandschaft von Zellulose, Chitin und Chitosan



What is Chitin/Chitosan?

Chitosan is a modified carbohydrate polymer derived from the *Chitin* component of the shells of crustacean, such as crab, shrimp and cuttlefish.



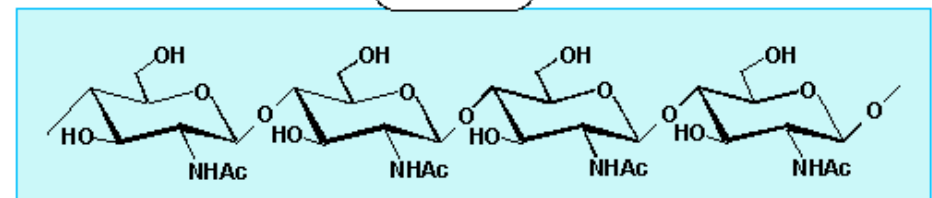
Shellfish wastes from food processing

Decalcification in dilute aqueous *HCl* solution

Deproteination in dilute aqueous *NaOH* solution

Decolorization in 0.5% *KMnO₄* aq. and *Oxalic acid* aq. or sunshine

Chitin



Deacetylation in hot concentrated *NaOH* solution (40-50%)

Chitosan

