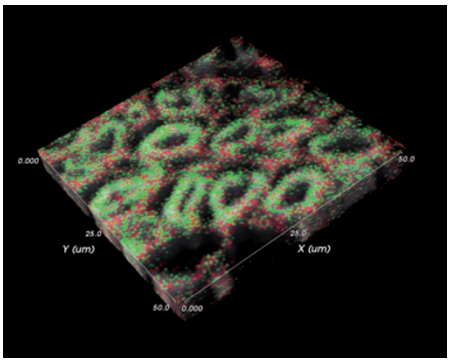
BIOMASS IMAGING

## In-depth description

*Angew. Chem. Int. Ed.* **51,** 12005–12008 (2012)






As the extensive use of fossil fuels over the past few decades has led to concerns over their depletion and negative impact on the environment, the scientific community is exploring alternative sources of energy — preferably renewable ones. Among those, lignocellulosic biomass obtained, for example, from agricultural and wood residues has emerged as a promising material. Owing to its complex structure, however, biomass is generally recalcitrant to the enzymatic hydrolysis treatments required to convert it into biofuel. Further progress on the conversion of biomass would be aided by a good understanding of its structure — but this has proved a tough problem to crack.

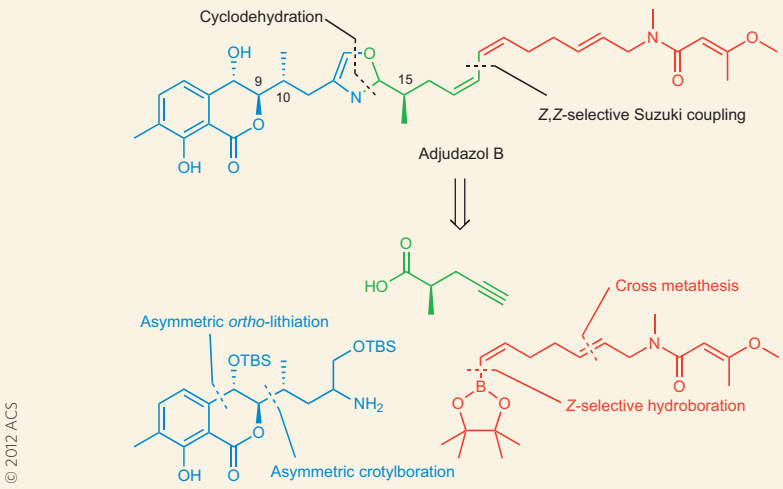
Various analytical methods have been used to try and characterize lignocellulosic biomass, and it has been found to comprise densely packed cellulose within a lignin–hemicellulose matrix. But techniques used so far typically give bulk information that doesn't portray accurately the heterogeneous nature of biomass. Using a time-of-flight secondary-ion mass spectrometry (TOF-SIMS) imaging method, a team of researchers led by Arthur Ragauskas at the Georgia Institute of Technology has now studied the three-dimensional distribution of cellulose and lignin in a 'tension wood' sample. This type of wood, which comes from the elongated side of a bent stem, has a characteristic cell structure that features a cellulose-rich gelatinous layer as well as a lignin-derived secondary cell wall. In TOF-SIMS, a primary ion beam is moved across a surface to dislodge target species and generate secondary ions that are characterized by mass spectrometry. Because this technique reveals the position on the surface from which a particular ion is formed, the distribution of a target species can be mapped.

Ragauskas and co-workers mapped both cellulose and lignin in the bulk of the tension wood sample by analysing it layer-by-layer: each layer was analysed then eroded, using a $Bi_3^+$ and an $O_2^+$ ion beam, respectively. A reconstruction step assembling all of the

STRUCTURE DETERMINATION

# Adjudazol assignment

*J. Am. Chem. Soc.* **134,** 19362–19365 (2012)






The incorrect functioning of a series of biochemical reactions known as the mitochondrial respiratory chain — responsible for the aerobic production of energy — has been implicated in the development of a variety of diseases. Adjudazols A and B are bacterial natural products that are known to inhibit some of the reactions involved and, as such, are interesting targets for total synthesis. The structures of adjudazols A and B contain three and four stereocentres, respectively; but the unusual architectures and rarity of these compounds mean that the configurations of these stereocentres has been a matter of debate.

Now, a team of researchers in Germany led by Dirk Menche from Bonn University along with co-workers from the universities of Heidelberg and Saarland have analysed the biosynthetic gene cluster responsible for the production of these compounds. This work has enabled them to fully assign the stereochemistry of these compounds and, on that basis, describe the first total synthesis of adjudazol B. Gene-cluster analysis has previously been used to assign the configuration of secondary alcohols in natural products (such as at C9 in adjudazol B, pictured) but, until now, had been less conclusive for stereocentres bearing methyl groups (such as at C10 and C15). Alternative methods of stereochemical assignment often rely on comparisons to known diastereomeric relationships in similar structures. Here, the fact that the C15 methyl substituent is remote from other stereocentres in the structure means that this approach is not particularly useful. Menche and co-workers were able to show that the configuration of the four stereocentres in adjudazol B could be attributed to the presence or absence of single amino acid residues in the enzymes responsible for the biosynthesis of this compound.

Having fully assigned the stereochemistry, Menche and co-workers set about a total synthesis of adjudazol B. A retrosynthetic analysis produced three fragments (pictured). The isochromanone core (blue) was arguably the most challenging fragment, requiring that chiral information is 'remembered' in the generation and reaction of an aryllithium. A cyclodehydration reaction with the carboxylic acid (green) containing the key C15 stereocentre led to formation of the oxazole and attachment of the polyene side chain (red) — itself constructed using cross metathesis — was achieved using a Suzuki cross-coupling reaction. *SD*