

Measures of Control

Hapalosiphon fontinalis is a busy little blue-green alga. It is known to produce a multitude of organic compounds, including the hapalindole alkaloids. These compounds have promising biological properties (including antibacterial and antimycotic activity) and complex structures, which makes them targets for total synthesis. **Michael Kerr**, MCIC and graduate student **Aaron Kinsman**, MCIC at the University of Western Ontario in London, ON have recently synthesized a member of this class of compounds, Hapalindole Q (1). Their synthesis is complete in eight short steps, furnishing the desired product in 12.4% overall yield. The route features a Diels Alder cycloaddition as the key step. The Diels Alder reaction, first described by Otto Diels and Kurt Alder, who later won the Nobel prize for their discovery, is one of the most powerful reactions in organic synthesis. It brings two flat molecules together to form a cyclic molecule, often with high levels of control of stereo and regio chemistry.

The key Diels Alder reaction in the Kerr synthesis (2 + 3 to 4) was not without challenges. The diene component (2) is unreactive and thus a Lewis acid catalyst and high pressures (13kbar) were examined to facilitate the reaction. However, the diene polymerized under these conditions complicating the purification of 4. Increasing the reactivity of the other component (dienophile 3) by introduction of a nitro group did the trick, and the Diels Alder cycloadduct was obtained in 60% yield with 72% diastereoselectivity.

The next key step in the synthesis was to open one of the rings formed in the Diels Alder and extend the resulting

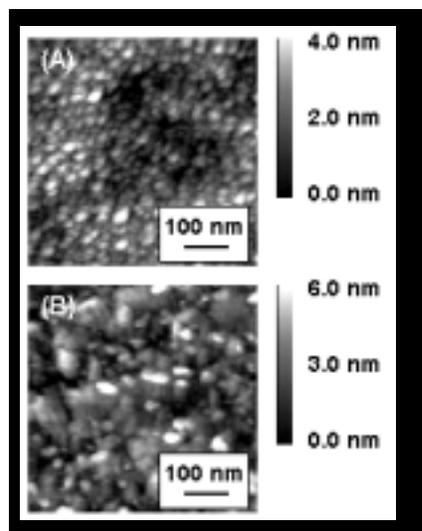
structure by two carbons. Although a ring opening metathesis was attempted, the olefin in 4 was too unreactive, even with a state of the art metathesis catalyst. The next standard reaction for this type of cleavage reaction is an ozonolysis reaction, which was attempted, but again, the olefin proved unreactive. Finally, the olefin succumbed to dihydroxylation and oxidative opening of the resulting diol. After a few functional group manipulations, the synthesis of Hapalindole Q was complete. For the complete synthesis of Hapalindole Q, see the original paper, published in *Organic Letters*, 3:3189, 2001.

Prospecting for Gold

What do you need to make self-assembled monolayers (SAMs)? A clean room? A vacuum line? Scrupulously clean and expensive gold substrates? A quartz crystal microbalance? In fact, **Hogan Yu**, MCIC at Simon Fraser University in Burnaby, BC has shown that all you need is a few recordable compact disks (CD-Rs), some alkanethiols, a splash of nitric acid, and a lot of ingenuity.

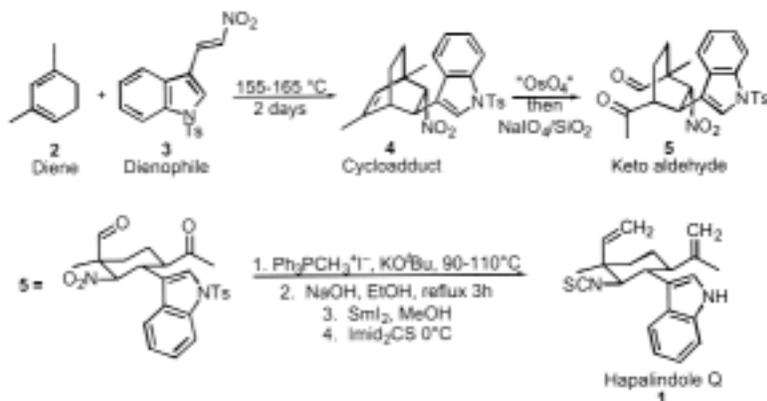
Yu has shown in a recent paper in *Analytical Chemistry* (73:4743, 2001), that removing the outer polymer coating from CD-Rs permits their use as substrates for the preparation of SAMs. Unlike traditional methods, only nitric acid is needed to peel off the protective polymer film, not the potentially explosive piranha reagent (H₂SO₄/H₂O₂) commonly employed for cleaning gold substrates prior to self-assembly.

Once the metal layer of the CD-R, which is pure gold, is exposed, it can be coated with alkanethiols that self-assemble



into a tightly packed monolayer with the thiol end bound to the gold surface. To examine the structure of the monolayer that is formed, Yu uses surface IR, wetting measurements and electrochemistry. When compared with SAMs prepared on commercially available gold surfaces designed for such applications, Yu finds no difference within the experimental uncertainty of the applied measurements. The SAMs are as closely packed and as ordered as those formed on evaporated gold substrates.

What's more, the gold film from CD-Rs actually has a slightly flatter morphology than the commercial gold substrates prepared by evaporation. Examining these surfaces by scanning tunneling microscopy (STM) provides an extreme close-up of the surface. Both substrates are polycrystalline and have a topology similar to rolling hills. The gold substrates prepared from CD-Rs have relatively uniform 'grains' on the surface, with an average size of 20-40 nm in diameter, and typical peak-to-valley heights of 3-4 nm (Figure A). The commercial gold substrates have a similar surface, but the crystallites are non-uniform, and the typical peak-to-valley height is higher than that of the gold substrates from CD-R's (Figure B). The large-scale STM images shows the 'track trails' on CD-R gold substrates that are typically 800 nm apart.



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