Laser science

CSIR laser scientists move at 'ultra-fast' speed

Dr Anton du Plessis

The CSIR's laser research capacity has just received a boost with the opening of its second femtosecond laboratory;a mere two years since the first lab's establishment. Femtosecond science involves the use of high-tech laser systems delivering femtosecond (ultra short) pulses with high peak intensities.

Speaking at the opening of the new lab, research group leader Dr Anton du Plessis said,

"Femtosecond science research is a long-term programme at the CSIR aimed at developing world-class expertise and facilities in this new field, which is at the cutting edge of scientific research. A femtosecond is minuscule – it is equal to one millionth of a billionth of a second. Just imagine - the ratio between the perceived age of the earth (4,55 billion years: 4 450 000 000 000) and a minute is approximately the same as that between a minute and a femtosecond. As atoms move in femtoseconds from one position to another, they break and form bonds in this time scale. With this technology, we can follow atoms as they move and react, much as in a video."

To date, the research group has made major strides; the opening of this lab being of particular relevance. Another significant achievement was the successful completion of a major industrial contract in which the feasibility of using femtosecond technology was investigated. In addition, four students have received their Masters' degrees, one student won a prize at the annual South African Institute of Physics conference and two research papers will be published in the next few months.

Femtosecond science has many applications. Du Plessis says, "This technology is highly interdisciplinary and can be used in diverse fields such as physics, biology, chemistry and even for micro drilling of various materials such as fibres. As unbelievable as it may sound, we were able to drill the letters 'NLC' on a single strand of hair." *See the image below*.

The femtosecond science research group forms part of the CSIR National Laser Centre. Its focus is on 'coherent control', which involves the use of coherent excitations (using a femtosecond laser) to control matter. The ultimate goal is to rearrange a molecule into new compounds by using only light. In this work, the group studies femtosecond laser pulse-induced molecular dissociation in a laser ionisation time of flight mass spectrometer. The next step is to apply these 'lessons' to mixtures of gases in a high pressure reaction cell and thereby attempt to induce and control chemical

reactions to produce selective reaction products, which would otherwise have taken place only at high temperatures and with mixtures of reaction products. The group has received interest for this type of work from numerous industry role-players, which Du Plessis, says, "looks promising".

He adds, "An ambitious project we hope to start soon is the study of laser-induced water splitting for hydrogen generation."

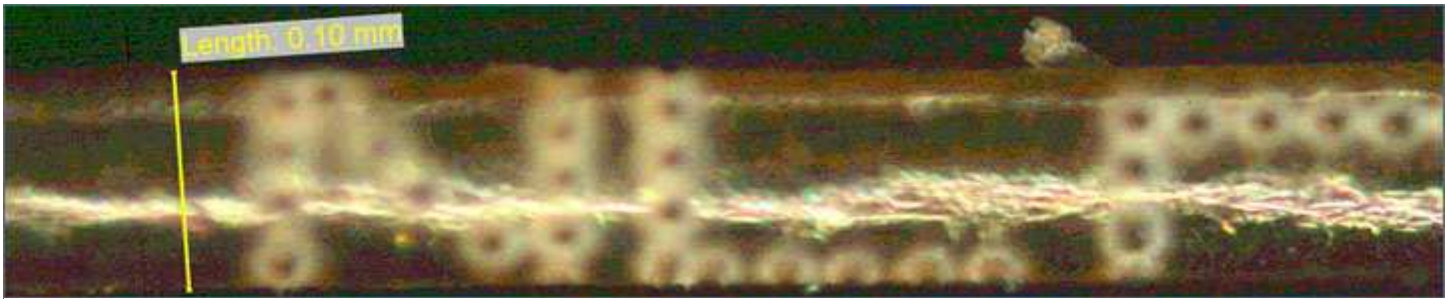

Image of the letters 'NLC' drilled onto a single strand of hair using a femtosecond laser

In another endeavour, the team is embarking on the use of the femtosecond laser for the de-activation of viruses. "With a femtosecond laser, indications are that we will be able to selectively destroy or deactivate viruses without any damage or mutation to other cells, for example blood cells.

This project aims to understand the physical mechanisms of the process and proving the principle in a lab setup. This work could play a major role in a future new dialysis treatment for patients with the human immunodeficiency virus, for example, although the technique could have countless other applications, not only in the medical field," explains

Du Plessis. The team is currently culturing its own colonies of *E.Coli*. bacteria and first experiments will be done with viruses that affect only bacteria, not humans (T4 and M13 bacteriophages).

Du Plessis adds, "I have a dedicated team, which includes six hardworking students, two contract researchers, a technician and a number of strong collaborators, who all love what they do. Thus, while the road ahead will entail lots of hard work, doing what we love makes it all worthwhile."

- Chiara Lincoln