Also holding a strong opinion was Drummen, who said there was no sense in using a super-resolution microscopy for pathological diagnostics in tissues and there was also no need to use super-resolution microscopy to determine if a cell nucleus became fragmented as a result of apoptosis as confocal laser scanning microscopy would suffice. He added that multiplex imaging might give a biomedical scientist, for instance, more data and a better feel than what a super-resolution microscope could offer, for the malignancy involved. For protein–protein interactions, Förster resonance energy transfer–fluorescence lifetime imaging is still the gold standard, he continued.

When asked what the challenges are ahead, Jungmann said that it would be the development of small, efficient and widely available affinity reagents for high-performance nanoscopy. His point was seconded by Drummen, who emphasized that the single most important issue will be fluorescent-probe engineering where the most gain is going to be achieved. Pape also agreed and commented that, "in the past decades, the technical versatility of different nanoscopy methods has evolved tremendously. Now precisions close to the size of fluorescent molecules are achievable, but finding compact and efficient labelling strategies remains challenging in many applications. The development of brighter, faster and more controllable probes is critical to exploit the technical possibilities."

Drummen also pointed out that other challenges include, for example, to push the limit further towards the resolution of electron microscopy, to increase the imaging speed in live-cell imaging, to allow imaging in thick samples, to develop adaptive optics to compensate for various forms of drift and to develop better algorithms for image reconstruction. He noted that, as also indicated by several of the other speakers, improvements in detection devices, such as charge-coupled device cameras, would help enormously. "There is still a lot to do and to gain," concluded Drummen.

Whether any of these challenges will be overcome within the next two years will remain to be seen at the next ICON Europe, which provisionally will be held in Oxford, UK, in March 2020. ❐

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VISION SCIENCE

Combating colour blindness

Coating a contact lens with a dye that has a suitable narrow-band absorption can help those with colour blindness better distinguish between confusing colours. That's the finding of researchers at the University of Birmingham, UK, who are now looking to start clinical trials and patent the approach (*Adv. Healthcare Mater.* https://doi.org/10.1002/adhm.201800152; in the press).

Haider Butt and his team added a commercially available fluorescent rhodamine dye (Atto 565 from Sigma-Aldrich) to the surface of homemade poly(2-hydroxyethyl methacrylate) and commercial silicone contact lenses by either a dipping or drop process. The dye strongly absorbs between 545 and 575 nm with a peak absorption at 565 nm, corresponding to the region of confusion for those that experience red–green colour blindness. The concept is that filtering out this overlapping band should help improve colour perception. The approach has already been proven using tinted spectacles that are commercially available, but the idea is now to apply it to contact lenses. "Several companies have started selling glasses for colour-blind patients and it's a race against time before they propose contact lenses as well," explained Butt.

In this latest study, 20 volunteers with normal vision and 50 with red–green colour deficiency, which is the most common condition, were asked to look at a series of Ishihara test slides (a standard colour-blindness test) via a glass slide that featured the dyed contact lens. They were then asked to comment on how it changed their perception of the test slide. All the participants, including those with normal vision, noted an improvement, but the level of improvement varied from person to person, especially for those with colour deficiency.

Credit: Haider Butt, University of Birmingham

Encouraged by the results, Butt's team is now looking to commence clinical trials and is in discussion with partners to commercialize the idea. "We have just received the ethical approval for the study and will be starting trials shortly," commented Butt. "Discussions are ongoing between commercial partners (one being Johnson and Johnson) and the University of Birmingham's commercial arm. We hope that the next stage of the project which involves crosslinking the dyes on to the commercial contact lenses will be patent protected."

Butt's study has already tested the biocompatibility of the dye-coated contact lenses by immersing them into cultures of human corneal epithelial cells and human corneal fibroblasts. In both cases, no signs of toxicity were observed and 99% of the cells remained viable after a period of 72 hours.

Work is now exploring the opportunities for the use of other dyes to help with other variants of colour blindness beyond red–green deficiency. "We have identified some dyes that are derivatives of rhodamine dyes which actively absorb the wavelength bands near 480 nm and can be used for producing lenses for purple–blue blindness," said Butt. "We are producing lenses for purple–blue blindness now and are also integrating multiple dyes onto contact lenses to make them perform for both red–green and purple–blue deficiencies simultaneously." ❐

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