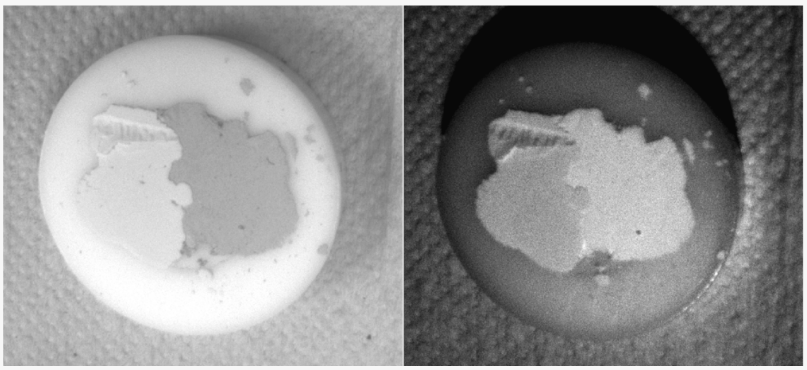
Researchers create new colour-changing material—could be used in anti-counterfeit markings on banknotes and passports

TURKU, FINLAND, September 4, 2026 /EINPresswire.com/ -- Researchers have developed a new material called davyne that changes colour in the near-infrared region. The colour change cannot be detected with the human eye, but only with a spectrometer or an infrared-sensitive camera. The material could be used, for example, as an invisible anti-counterfeit tag.



Colour change in davyne is visible only in infrared light. The pictures have been taken after UV exposure in white light (light picture) and in near-infrared light under NIR-LED (dark picture). Davyne and hackmanite are side-by-side on the round disk. In

When studying the properties of hackmanite, researchers were able to create a new material called davyne. Hackmanite is a natural mineral that can also be produced synthetically and whose features and applications have been studied and further developed by the Intelligent Materials Chemistry Group of the University of Turku in Finland. Hackmanite is photochromic, meaning that it can change its colour from white to pink or violet upon UV exposure. The colour reverts back to the original once hackmanite is exposed to white light for a suitable period or when it is heated to 100oC.

> The advantage of davyne over other invisible anti-counterfeit marking materials is that its near-infrared activity can be switched on and off."
>
> *Professor Mika Lastusaari*

In a recently published study, the researchers developed a new material related to hackmanite called davyne that changes colour in the near-infrared region. The colour change cannot be detected with the human eye, but only with a spectrometer or an infrared-sensitive camera. The researchers studied what caused the colour change and tested the material's possible applications.

"The development of this new material began with a thesis project carried out by a student in our research group. The project demonstrated that the colour-changing properties of

hackmanite are altered when calcium is introduced to the material instead of sodium. Rather than turning pink or violet, the material turned yellow. We also noticed that some of the material samples did not change colour visibly, but similar colour changes occurred in the near-infrared region, which is invisible to the human eye," says Principal Investigator, Professor Mika Lastusaari from the University of Turku.

The material that turned yellow was calcium hackmanite, but the active material in the near-infrared region was davyne, which belongs to the cancrinite mineral family. Davyne was produced during the study as a by-product of calcium hackmanite synthesis. Calcium hackmanite and davyne have the same chemical formula, but their atomic structures are different.

In the early stages of the study, the researchers found it difficult to produce pure davyne, as the material's chemical equilibrium seemed to shift more readily towards calcium hackmanite than towards davyne. The research group continued to optimise the material and develop the manufacturing process in collaboration with materials engineering researchers, utilising, among other things, machine learning methods developed in materials engineering. In the end, the researchers succeeded in producing the purest possible form of davyne.

"At this stage, however, it was still a mystery to us what causes the colour change. We assumed that the mechanism was similar to that of hackmanite, where the colour change is caused by the transfer of an electron from a specific ion to a chlorine vacancy in the structure, and the size of this vacancy determines the colour the material turns into. However, davyne's structure is different and the material has long, empty tunnels instead of the cavities that are typical to hackmanite. At the end, we were able to show that the colour-changing mechanism of davyne is similar to hackmanite," Lastusaari says.

The researchers say that davyne is the only known material to change colour so that it cannot be detected with the human eye. The material could have various applications, such as authenticity or security markings. The study also tested the feasibility of these applications.

"These kind of anti-counterfeit tags are used in banknotes, passports and other official documents as well as in many consumer products. We tested the functionality of davyne using an inexpensive camera from which all the colour detection filters had been removed, so that the remaining silicon chip detected a wavelength range specifically suited to davyne."

The tests showed that davyne's colour change is clearly detectable under infrared light when the camera's sensitivity is adjusted to davyne.

"The advantage of davyne over other invisible anti-counterfeit marking materials is that its near-infrared activity can be switched on and off. In practice, this means that the marking can be activated so that it is visible for inspection, and then returned to an invisible state," Lastusaari says.

The study was conducted by the Intelligent Materials Chemistry Group of the University of Turku in collaboration with the University's Department of Materials Engineering and Department of Physics and Astronomy. Research partners also included Aalto University in Finland, the National Institute of Chemical Physics and Biophysics in Tallinn, Estonia, and the University of Lyon in France.

The study was published in the distinguished Angewandte Chemie journal.

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