Bio Focus

Gold nanoparticles enable instant colorimetric hydration sensor

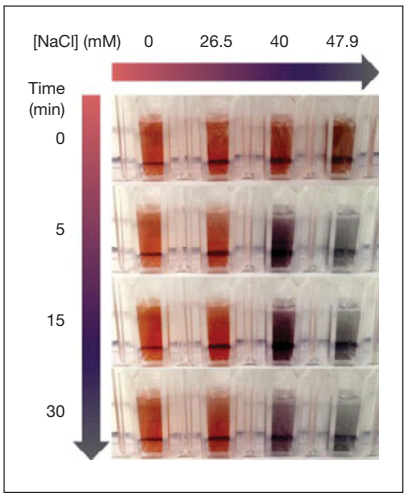
During sports activities, monitoring hydration status before, during, and after exercise is essential for both performance and safety. Y. Zhou of Nanyang Technological University, Souhir Boujday of Sorbonne Universités in Paris, and their colleagues have now developed a gold nanoparticle-based colorimetric sensor that makes it possible to detect hydration balance and overhydration within minutes. They reported their work in the journal *Materials & Design* (DOI: 10.1016/j.matdes.2015.06.078).

The researchers used ascorbic acid-stabilized gold nanoparticles (AuNPs) in this work. To obtain a model mixture with the necessary concentration of the AuNPs, 100 µL of 100 g L^{-1} chloroauric acid ($HAuCl_4 \cdot 3H_2O$) was mixed with 25 mL of de-ionized water and 1.5 mL of 21.2 g L^{-1} sodium carbonate solution. To complete the synthesis, 2 mL of 7 g L^{-1} ascorbic acid underwent vigorous stirring at 1000 rpm on a magnetic stirrer for 15 min. The mixed solution was chilled with ice at about 0–2°C. The designed mixture model had the concentration range of human body fluid.

Different colors were obtained at NaCl concentrations of 26.5 mM, 40 mM, and 47.9 mM, which indicate that the sensor can distinguish between hydration imbalance situations. As the concentration of NaCl increased from 26.5 mM to 40 mM and 47.9 mM, the A650/A520 ratio increased, indicating a decrease in dispersed particles and an increase in AuNP aggregates. The ratio of absorbance at 650–520 nm (A650/A520) is a good indicator of the aggregation state of the AuNPs. The particles' aggregation/dispersion state occurred in the desired range of salt concentration.

The researchers envision this type of sensor to be used for detection of hydration levels with many desirable properties, including simple detection display, high stability, and fast response time. Furthermore, this model of sensor may be useful in detecting small changes in biological substances in excreted fluids.

Jean Njoroge



The different color of AuNPs solution in the presence of different concentrations of NaCl. Credit: *Materials & Design*.

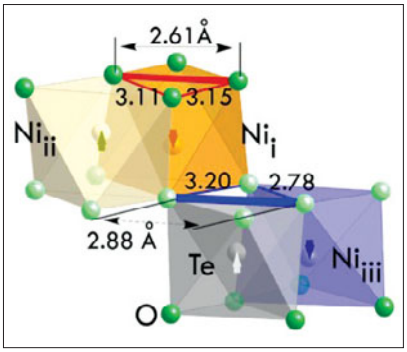
Ni_3TeO_6 crystal structure exhibits interlocked chiral and polar domain walls

Coexisting optical and polar domains have been found in single-crystal Ni_3TeO_6. Furthermore, these domains are intertwined—the optical orientation, directly related to structural chirality, determines the polar orientation and vice versa. A group at Rutgers, The State University of New Jersey led by Sang-Wook Cheong reports these findings in *APL Materials* (DOI: 10.1063/1.4927232). This is the first known report of a crystal that has been found to show intertwined optical and polar domains.

"After getting high-quality single crystals of Ni_3TeO_6 (NTO), we happened to observe domain inversion under a transmission polarized optical microscope," Cheong tells *MRS Bulletin*. "Since the crystal group Ni_3TeO_6 is noncentrosymmetric, it's natural to test the piezoresponse by PFM [piezo force microscope] scanning." Such crystals have no center of symmetry, and show charge polarization, which is necessary for the piezoelectric effect—the propensity of certain materials to develop a surface charge when squeezed. PFM is a method of directly observing this behavior using an atomic force microscope. Optical activity is the rotation of plane-polarized light as it passes through a material.

Most crystals are found to be divided into smaller regions based on their polar/optical responses. The macroscopic behavior of a crystal is then the average behavior of all these domains. Some optical domains may rotate light counterclockwise while other domains rotate it clockwise. Similarly, polar domains have dipoles orientated in different directions. In NTO, if adjacent domains rotate light right-left, the corresponding polarization is found to be either up-down or down-up. Thus, an optical domain in NTO is also a polar domain and vice versa since their domain walls coincide. The polar domains in a hexagonal single crystal of NTO resemble the trefoil symbol for radiation danger.

The group explains this correlation through the crystal structure of the material. NTO has a corundum (Al_2O_3) crystal structure with nickel and tellurium occupying the sites traditionally reserved for aluminum. Each of the metal ions is surrounded by six oxygen atoms forming



The basic building block of Ni_3TeO_6. Credit: *APL Materials*.

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