Nanospace-controlled gold material created using molecular technology

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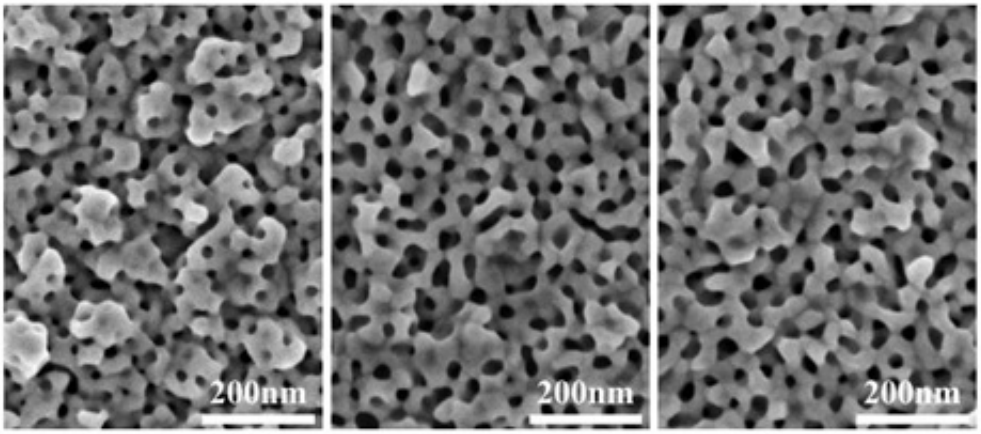

Electron micrographs of nanoporous gold materials that were fabricated using different sizes of micelles. Pore size increases from left to right.

A research group led by Yusuke Yamauchi, an Independent Scientist at the International Center for Materials Nanoarchitectonics (MANA), NIMS, in cooperation with other research organizations in Japan and overseas, successfully developed a nanoporous gold material with a regular, uniform pore arrangement using polymers as a template.

Nanoporous materials, having internal pores of several-nanometers in diameter and a large surface-to-volume ratio, have the potential of producing novel chemical reactions, and thus have been vigorously studied in the pursuit of developing new catalyst and absorbent materials. In particular, it has been proposed to apply nanoporous gold

materials to various fields such as electronics, catalysts and medicine, and it has been reported that they were processed into various forms such as gold nanoparticles, gold nanorods and gold nanowires. However, these conventional nanoporous gold materials have rather irregular pore arrangements, and it had been hoped to fabricate nanoporous gold materials whose pore size can be freely manipulated.

In recent years, it has become feasible to synthesize mesoporous metals with a metal framework by using amphipathic molecules (e.g., surfactants) as a template. In this study, we created uniformly sized spherical micelles (molecular assembly) by adjusting the concentration of polymers that possess both hydrophobic and hydrophilic properties (amphipathic block copolymers) in a dilute solution. Using these polymers as a template, we reduced gold ions while precisely controlling electrolytic deposition, resulting in the successful formation of nanopores, whose sizes corresponded to the sizes of the micelles used, over the surfaces of the gold films.

In the pores of the nanoporous gold materials, we observed a strong electric field and surface enhanced Raman scattering (SERS). It is expected that these distinctive properties will have various applications such as a SERS-activate substrate for molecular sensing and electrode catalyst. Also, this technology is applicable to various metals and alloys in addition to gold. Furthermore, since pore size can be adjusted to various diameters by changing the molecular size of the block copolymers, it is feasible to design metal nanospace materials that meet specific needs of users in terms of composition and structure.

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