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Recently, researchers from Vienna University of Technology (TU Wien) have discovered a novel way to fabricate pure gold nanostructures by the additive direct-write lithography called FEBID. This work will open a new door for applications of 3D gold devices. The work has recently been published in nature publication group's journal, Scientific Report, on September 26, 2016.

Gold is not only a noble metal of exceptional beauty, but also a highly desired material for functional nanostructures. Especially patterned gold nanostructures are key enabling structures in plasmonic devices, for biosensors with immobilized antibodies and as electrical contacts. For decades the fabrication of pure gold nanostructures on non-planar surfaces as well as of 3-dimensional gold nanostructures has been the bottleneck. Up to now only 2-dimensional gold nanostructures on planar surfaces were achievable by resist based lithography.

Focused electron beam induced deposition (FEBID) is a mask-less, resist-less method that can fabricate custom-designed 2D and 3D nanostructures in a single process step. The principle is the local decomposition of a metalorganic precursor by the focused electron beam of an electron microscope. It has been recently demonstrated that FEBID can be used for 3D nano-manufacturing of most complex 3D structures – just like a 3D-printer on the nanoscale (*ACS Nano 10 (6), 6163 (2016)*. With a resolution limit of 1 nm, FEBIP was shown beating other existing nanofabrication methods (*Nano Letters 5 (7), 1303 (2005)*). To get the material purity right was the final obstacle of FEBID, as the electron-induced decomposition of metalorganic precursors has typically yielded metals with high carbon contaminations. This last bottleneck on the road to custom-designed, pure gold nanostructures has been overcome as described in the work on "Highly conductive and pure gold nanostructures grown by electron beam induced deposition" published in *Scientific Reports 6, 34003 (2016)*.

While conventional FEBID gold deposition usually contains about 70 atomic % carbon and only 30 atomic % gold, a new approach developed by a research group lead by Dr. Heinz Wanzenboeck at TU Wien has allowed to fabricate pure gold structures by in-situ addition of an oxidizing agent during the gold deposition. According to Dr. Wanzenboeck, "The whole community was working hard for the last 10 years to directly deposit pure gold nanostructures." At last the group's expertise in engineering and chemical reactions paid off and direct deposition of pure gold was successful. "It's a bit like discovering the legendary philosopher's stone that turns common, ignoble material into gold" joked Dr. Wanzenboeck.

This deposited pure gold structure exhibits extremely low resistivity near that of bulk gold. Generally, a FEBID gold structure has a resistivity around 1-Ohm-cm which is about 1 million times worse than the resistivity of purest bulk gold. However, this specially enhanced FEBID process produces a resistivity of 8.8 micro-Ohm-cm which is only a factor 4 away from the bulk resistivity of purest gold (2.4 micro-Ohm-cm).

The authors of the paper Dr. Mostafa Moonir Shawrav and Dipl.Ing. Philipp Taus stated, “This highly conductive and pure gold structure will open a new door for novel nanoelectronic devices. For example, it will be easier to produce pure gold structures for nanoantennas and biomolecule immobilization which will change our everyday life”. Dr. Shawrav added “it is remarkable how a regular SEM (Scanning Electron Microscope) nowadays can deposit nanostructures compared to 20 years back when it was only a characterization device”. And with pure gold direct deposition available now, he expects nanodevices to be deposited directly and utilized in many different applications for technological revolution. Concluding, this work is a giant leap forward for 3D nano-printing of gold structures which will be the core part of nanoplasmonics and bioelectronics devices.

The work is funded by Austrian Science Fund (P24093). The article is freely accessible via: http://www.nature.com/articles/srep34003. For more information about the bionanobeam research group, please visit: http://bionano.eu/ or contact any of the following authors.

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