

Highlights from recent literature

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Each issue of *Gold Bulletin* contains key highlights from the research and patent literature. Authors who publish high quality work in other journals are invited to send a copy of their publication to the Editor for inclusion in the next issue.

Nanotechnology

In situ synthesis of nanoparticles on substrates by ink-jet printing

Nanoparticles may be formed on a substrate by mixing precursor solutions deposited by an ink-jet printer, as described in patent US2013316482 (A1). A first solution is deposited on a substrate from a first ink-jet print cartridge. Then, a second solution is deposited on the substrate from a second ink-jet print cartridge. The solutions may be printed in an array of droplets on the substrate. Nanoparticles form when droplets of the first solution overlap with droplets of the second solution. In one example, the nanoparticles may be gold nanoparticles (Au NPs) formed from mixing a first solution of 1,2-dichlorobenzene (DCB) and oleylamine and a second solution of gold chloride trihydrate and dimethyl sulfoxide (DMSO). The nanoparticles may be incorporated into optoelectronic devices.

Seeing through bone with surface-enhanced spatially offset Raman spectroscopy

Surface-enhanced spatially offset Raman spectroscopy (SESORS) is a label-free vibrational spectroscopy that has the potential for in vivo imaging. Previous SESORS experiments have been limited to acquiring spectra using surface-enhanced Raman spectroscopy (SERS) substrates implanted under the skin or from nanoparticles embedded in tissue. Here a team from the USA present SESORS measurements of SERS active nanoparticles coated with a Raman reporter

molecule (nanotags) acquired, for the first time, through bone (Sharma et al., *J. Am. Chem. Soc.*, 2013, 135 (46), pp 17290–17293 DOI: [10.1021/ja409378f](https://doi.org/10.1021/ja409378f)). The ability of SESORS to measure spectra through various thicknesses (3–8 mm) of bone is demonstrated. Also shown is that diluted nanotag samples ($\sim 2 \times 10^{12}$ particles) can be detected through the bone. A least squares support vector machine analysis to demonstrate quantitative detection was applied. It is believed that these through-bone SESORS measurements will enable real-time, noninvasive spectroscopic measurement of neurochemicals through the skull, as well as other biomedical applications.

Plasmon-mediated syntheses of metallic nanostructures

The ability to prepare noble metal nanostructures of a desired composition, size, and shape enables their resulting properties to be exquisitely tailored, which has led to the use of these structures in numerous applications, ranging from medicine to electronics. The prospect of using light to guide nanoparticle reactions is extremely attractive since one can, in principle, regulate particle growth based on the ability of the nanostructures to absorb a specific excitation wavelength. Therefore, using the nature of light, one can generate a homogenous population of product nanoparticles from a heterogeneous starting population. The best example of this is afforded by plasmon-mediated syntheses of metal nanoparticles, which use visible light irradiation and plasmon excitation to drive the chemical reduction of Ag^+ by citrate. Since the initial discovery that Ag triangular prisms could be prepared by the photo-induced conversion of Ag spherical nanoparticles, plasmon-mediated synthesis has become a highly controllable technique for preparing a number of different Ag particles with tight control over shape, as well as a wide variety of Au–Ag bimetallic nanostructures. This review, written by Chad Mirkin and colleagues, discusses the underlying physical and

chemical factors that drive structural selection and conclude by outlining some of the important design considerations for controlling particle shape as learned through studies of plasmon-mediated reactions, but applicable to all methods of noble metal nanocrystal synthesis (Langille et al., *Angew. Chem. Int. Ed.*, DOI: [10.1002/anie.201301875](https://doi.org/10.1002/anie.201301875)).

Post-synthesis reshaping of gold nanorods using a femtosecond laser

Polish and French researchers describe the interaction between femtosecond laser pulses (~130 fs, 800 nm) and gold nanorods (NRs) leading to reshaping of the NRs (*Phys. Chem. Chem. Phys.*, 2014, 16, 71–78, DOI: [10.1039/C3CP53457J](https://doi.org/10.1039/C3CP53457J)). The investigation was focused on the structural changes of the NRs and the parameters influencing the reshaping, like surface modification using sodium sulfide, laser power, and the position of the longitudinal surface plasmon resonance band (L-SPR) with respect to the laser wavelength. A thermogravimetric analysis experiment was performed to examine changes in the composition of NRs upon heating. A new type of banana-shaped NPs is described and the conditions of their appearance are discussed.

Star-shaped magnetite@gold nanoparticles for protein magnetic separation and SERS detection

A novel synthetic methodology for star-shaped gold-coated magnetic nanoparticles is reported by Spanish researchers (Quaresma et al., *RSC Adv.*, 2013,, Accepted Manuscript, DOI: [10.1039/C3RA46762G](https://doi.org/10.1039/C3RA46762G)). The coating is performed in two steps: the formation of gold nuclei at the surface of magnetite nanoparticles followed by the growth of the gold nuclei into a complete star-shaped shell. The star-shaped gold-coated magnetic nanoparticles thus obtained preserve the magnetic properties of the precursor magnetite nanoparticles, e.g., they can be easily separated with a magnet. In addition, the gold coating provides interesting optical properties while simultaneously allowing for biofunctionalization that may be advantageous for biological applications, such as (bio) detection via SERS. As a proof of concept, a capping agent terminated with a nickel(II)-nitriolotriacetate group showing high affinity for histidine was used to modify the surface of the nanoparticles. The resulting star-shaped nanoparticles were used to selectively capture histidine-tagged maltose-binding protein from a crude cell extract. Finally, the performance of star shaped gold-coated magnetic nanoparticles as SERS platforms was demonstrated through the detection of Raman active dye (astra blue).

Nanowired three-dimensional tissue scaffolds

Electrically conductive nanowires incorporated within scaffolds enhance tissue growth, bridge the electrically resistant pore walls and markedly improve electrical communication between adjacent cardiac cell bundles according to researchers from MIT (Patent US2013289687 (A1)). Integration of conducting nanowires within three-dimensional (3D) scaffolds should improve the therapeutic value of cardiac patches. Examples demonstrate efficacy of gold nanowires in alginate matrices seeded with cardiomyocytes.

One-step highly sensitive detection of melamine using gold nanoparticle-based dynamic light scattering

Chinese researchers describe the development of a dynamic light scattering (DLS)-based approach for the real-time detection of melamine (Ma et al., *Anal. Methods*, 2014, Advance Article, DOI: [10.1039/C3AY41711E](https://doi.org/10.1039/C3AY41711E)). Due to the strong interaction between melamine and Au NPs, the hydrodynamic diameter of Au NPs changed with increasing amounts of added melamine in the detection system, which can be directly observed by DLS. The sensitivity of this assay to detect melamine is about 0.05 ppm, and even in detection solutions with low pH values (2.5–3.5 or 4.0–5.0), this DLS-based assay can work well. All these results suggest that the DLS-based assay could be a good alternative method for one-step real-time detection of melamine, especially in complex systems (such as complex solutions with a low pH environment), without time-consuming procedures and costly instruments.

In situ gold-loaded titania photonic crystals with enhanced photocatalytic activity

A facile two-step method is developed to fabricate 3D ordered macroporous (3DOM) gold-loaded titania (TiO₂) photonic crystals with enhanced photocatalytic activities (Cai et al., *J. Mater. Chem. A*, 2014, Advance Article, DOI: [10.1039/C3TA13878J](https://doi.org/10.1039/C3TA13878J)). Firstly, a mixed solution of polystyrene (PS) colloids, chloroauric acid, and titanium(IV)-bis-lactato-bisammonium dihydroxide (TiBALDH) sol was co-assembled into PS/TiO₂ colloidal crystal films. Subsequent calcination of the samples led to the removal of PS and transformed amorphous TiO₂ into the anatase phase. The resultant 3DOM inverse TiO₂ opals (i-TiO₂-o) and gold-loaded i-TiO₂-o (i-Au-TiO₂-o) show centimeter-scale long-range ordering. Photocatalytic characterization of i-TiO₂-o and i-Au-TiO₂-o showed activities twofold and fivefold higher than nanocrystalline TiO₂, respectively. This enhanced photocatalytic performance can be attributed to the synergetic effect of slow photons near the absorption edge of anatase TiO₂ nanocrystals and chemically amplified photochemistry.

The present method is much more simple and straightforward than conventional colloidal crystal templating methods. In particular, the Au NPs can be in situ loaded into the inverse opal structure with controllable size and content. Furthermore, both *i*-TiO₂-o and *i*-Au-TiO₂-o films fabricated by this method show a highly ordered structure without overlayers in a large area, which facilitates the adsorption of target pollutants and ultimate utilization of solar energy.

Palladium-nanoparticle-modified and gold-nanoparticle-modified porous carbon as a high-power anode for lithium-ion batteries

Ultrahigh-power insertion-type anodes are developed by simply decorating Pd and Au nanoparticles on commercially available porous carbon (Raghu et al., *ChemPhysChem*, Volume 14, Issue 17, pages 3887–3890, December 2, 2013).

Electronics

Comparative reliability studies and analysis of Au, Pd-coated Cu and Pd-doped Cu wire in microelectronics packaging

Malaysian researchers compare and discuss the wear-out reliability and analysis of Gold (Au), Palladium (Pd)-coated Cu and Pd-doped Cu wires used in fineline Ball Grid Array (BGA) package (Leong & Uda, *PloS One*, DOI: [10.1371/journal.pone.0078705](https://doi.org/10.1371/journal.pone.0078705)). Intermetallic compound (IMC) thickness measurement was carried out to estimate the coefficient of diffusion (D_0) under various aging conditions of different bonding wires. Wire pull and ball bond shear strengths have been analyzed with smaller variations in Pd-doped Cu wire compared to Au and Pd-doped Cu wire observed. Au bonds were identified to have faster IMC formation, compared to slower IMC growth of Cu. The obtained weibull slope, β of three bonding wires are greater than 1.0 and belong to wear-out reliability data point. Pd-doped Cu wire exhibits larger time-to-failure and cycles-to-failure in both wear-out reliability tests in Highly Accelerated Temperature and Humidity (HAST) and Temperature Cycling (TC) tests. This proves Pd-doped Cu wire has a greater potential and higher reliability margin compared to Au and Pd-coated Cu wires.

SiC die attach for high-temperature applications

Eutectic solders AuIn₁₉ and AuGe₁₂ and nanosilver paste were investigated for SiC die attach in high-temperature (300 °C) applications (Drevin-Bazin et al., *Journal of Electronic Materials*, DOI [10.1007/s11664-013-2718-5](https://doi.org/10.1007/s11664-013-2718-5)). The soldering or sintering conditions were optimized through die shear tests performed at room temperature. In particular, application of static pressure (3.5 MPa) during sintering

resulted in greatly improved mechanical behavior of the nanosilver-based joint. Microstructural study of the eutectic solders showed formation of Au-rich grains in AuGe die attach and significant diffusion of Au and In through the Ni layer in AuIn₁₉ die attach, which could lead to formation of intermetallic compounds. Die shear tests versus temperature showed that the behaviors of the studied die attaches are different; nevertheless, they present suitable shear strengths required for high-temperature applications. The mechanical behavior of joints under various levels of thermal and mechanical stress was also studied. Creep experiments were carried out on the eutectic solders to describe the thermomechanical behavior of the complete module; only one creep mechanism was observed in the working range.

Fuel cells

Dispersing Pt atoms onto nanoporous gold for high performance direct formic acid fuel cells

Direct formic acid fuel cells (DFAFCs) are promising portable energy conversion devices for supplying our off-grid energy demands. However, traditional Pt-based catalysts suffer from poor performance; consequently, the precious metal loading in an actual fuel cell has to be maintained at a very high value, typically orders of magnitude higher than the acceptable level. Through a molecular self-assembly/electrodeposition process, Pt atoms are effectively dispersed onto the surface of a nanoporous gold substrate, and the resulting nanocomposites demonstrate superior electrocatalytic performance toward formic acid electrooxidation, which can be attributed to a nearly ideal catalyst configuration where all the Pt atoms are involved in a highly desired direct reaction path. In both half-cell electrochemical testing and actual DFAFCs, these rationally designed electrodes show over two orders of magnitude improvement in Pt efficiency, as compared with the state-of-the-art Pt/C catalyst. This design strategy allows customized development of new generation electrocatalysts for high performance energy saving technologies, according to Chinese and Japanese researchers (*Chem. Sci.*, 2014,5, 403–409, DOI: [10.1039/C3SC52792A](https://doi.org/10.1039/C3SC52792A)).

Catalysis

Catalysts, activating agents, support media, and related methodologies useful for making catalyst systems especially when the catalyst is deposited onto the support media using physical vapor deposition

Use of physical vapor deposition methodologies to deposit nanoscale gold on activating support media makes the use of

catalytically active gold dramatically easier and opens the door to significant improvements associated with developing, making, and using gold-based, catalytic systems according to 3M scientists (Patent US2013309158 (A1)). The present invention, therefore, relates to novel features, ingredients, and formulations of gold-based, heterogeneous catalyst systems generally comprising nanoscale gold deposited onto a nanoporous support.

An efficient one pot conversion of glycerol to lactic acid using bimetallic gold-platinum catalysts on a nanocrystalline CeO₂ support

The one pot conversion of glycerol to lactic acid using monometallic Au and Pt as well as bimetallic (Au–Pt) catalysts supported on nanocrystalline CeO₂ (n-CeO₂) in aqueous solution in the presence of a base and oxygen was investigated by Dutch researchers (Purushothaman et al., Applied Catalysis B, 2013, <http://dx.doi.org/10.1016/j.apcatb.2013.07.068>). Catalytic performance of the bimetallic catalysts is considerably better than the monometallic ones and is indicative for synergistic effects. The bimetallic system shows excellent activity (TOF=1170 h⁻¹ for a batch time of 20 min) with a high selectivity (80 %) to lactic acid at 99 % glycerol conversion (373 K, NaOH to glycerol ratio of 4 mol/mol 5 bar oxygen). The Au-Pt/nCeO₂ catalyst was recycled five times in a batch setup without a significant drop in activity and lactic acid selectivity, indicative for good catalyst stability.

Hydrogenation catalysts, method for making the same and use thereof for preparing hydrogen peroxide

The present invention (WO2013160163) describes a hydrogenation catalyst based on palladium on a silicon oxide (SiO₂), on an aluminium oxide (Al₂O₃), or on an aluminosilicate support, wherein the catalyst comprises an amount of palladium from 1.5 to 2.5 % by weight with respect to the weight of the catalyst and an amount of silver 0.1 to 0.5 % by weight with respect to the weight of the catalyst, and wherein preferably the catalyst further comprises gold in an amount of up to 0.1 % by weight with respect to the weight of the catalyst. The preferred support in an embodiment of the invention is a delta-aluminium oxide (delta-Al₂O₃) support. The catalyst may be used in manifold hydrogenation types, and preferably the catalyst is proposed to be used in the manufacture of hydrogen peroxide by the auto-oxidation process.

Monodisperse Au nanoparticles for selective electrocatalytic reduction of CO₂ to CO

Zhu et al. report selective electrocatalytic reduction of carbon dioxide to carbon monoxide on Au NPs in 0.5 M KHCO₃ at 25 °C (*J. Am. Chem. Soc.*, 2013, 135 (45), pp 16833–16836 DOI: [10.1021/ja409445p](https://doi.org/10.1021/ja409445p)). Among monodisperse 4, 6, 8, and

10 nm NPs tested, the 8 nm Au NPs show the maximum Faradaic efficiency (FE) (up to 90 % at -0.67 V vs reversible hydrogen electrode, RHE). Density functional theory calculations suggest that more edge sites (active for CO evolution) than corner sites (active for the competitive H₂ evolution reaction) on the Au NP surface facilitates the stabilization of the reduction intermediates, such as COOH*, and the formation of CO. This mechanism is further supported by the fact that Au NPs embedded in a matrix of butyl-3-methylimidazolium hexafluorophosphate for more efficient COOH* stabilization exhibit even higher reaction activity (3 A/g mass activity) and selectivity (97 % FE) at -0.52 V (vs RHE). The work demonstrates the great potential of using monodisperse Au NPs to optimize the available reaction intermediate binding sites for efficient and selective electrocatalytic reduction of CO₂ to CO.

Supporting palladium metal on gold nanoparticles improves its catalysis for nitrite reduction

Nitrate (NO₃⁻) and nitrite (NO₂⁻) anions are often found in groundwater and surface water as contaminants globally, especially in agricultural areas due to nitrate-rich fertilizer use. One popular approach to studying the removal of nitrite/nitrate from water has been their degradation to dinitrogen via Pd-based reduction catalysis. However, little progress has been made toward understanding how the catalyst structure can improve activity. Focusing on the catalytic reduction of nitrite in this study, researchers from Rice University report that Au NPs supporting Pd metal (“Pd-on-Au NPs”) show catalytic activity that varies with volcano-shape dependence on Pd surface coverage (Qian et al., *Nanoscale*, 2014, *Advance Article*, DOI: [10.1039/C3NR04540D](https://doi.org/10.1039/C3NR04540D)). At room temperature, in CO₂-buffered water, and under H₂ headspace, the NPs were maximally active at a Pd surface coverage of 80 %, with a first-order rate constant ($k_{\text{cat}}=576 \text{ L g}_{\text{Pd}}^{-1} \text{ min}^{-1}$) that was 15× and 7.5× higher than monometallic Pd NPs (~4 nm; $40 \text{ L g}_{\text{Pd}}^{-1} \text{ min}^{-1}$) and Pd/Al₂O₃ (1 wt% Pd; $76 \text{ L g}_{\text{Pd}}^{-1} \text{ min}^{-1}$), respectively. Accounting only for surface Pd atoms, these NPs ($576 \text{ L g}_{\text{surface-Pd}}^{-1} \text{ min}^{-1}$) were 3.6× and 1.6× higher than monometallic Pd NPs ($160 \text{ L g}_{\text{surface-Pd}}^{-1} \text{ min}^{-1}$) and Pd/Al₂O₃ ($361 \text{ L g}_{\text{surface-Pd}}^{-1} \text{ min}^{-1}$). These NPs retained ~98 % of catalytic activity at a chloride concentration of 1 mM, whereas Pd/Al₂O₃ lost ~50 %. The Pd-on-Au nanostructure is a promising approach to improve the catalytic reduction process for nitrite and, with further development, also for nitrate anions.

Gold-catalyzed synthesis of tetrazoles from alkynes by C–C bond cleavage

Tetrazoles are formed by the reaction of alkynes with TMSN₃ (trimethylsilyl (TMS)) in the presence of *i*PrOH and the

gold(I) catalyst [JohnPhosAu(MeCN)]SbF₆. In this transformation gold plays a dual role, first activating the alkyne and then generating a Brønsted acid in situ according to Gaydou and Echavarren (Angew. Chem. Int. Ed., DOI: [10.1002/anie.201308076](https://doi.org/10.1002/anie.201308076)).

Evaluation and mechanistic investigation of AuPd alloy catalyst for the HC-SCR of NO_x

The ability of a gold palladium bimetallic catalyst to selectively oxidize toluene has been used to enhance the hydrocarbon selective catalytic reduction (HC-SCR) of NO_x, a reaction in which the interaction of partial oxidation intermediates is considered important (Hamill et al., Applied Catalysis B: Environmental, Volume 147, 5 April 2014, Pages 864–870). The combination of gold with palladium has a synergistic effect, producing a catalyst that is more active for NO_x conversion than the arithmetic sum of the corresponding monometallic materials. Three regimes in the conversion profile of the AuPd catalyst are proposed relating to production and consumption of toluene derived species, such as benzaldehyde and benzonitrile. The possible role of these reaction intermediates in the toluene HC-SCR reaction is examined. Using ¹⁵N₂O, the formation of N₂ and N₂O is observed via the direct interaction between the nitrogen atom of benzonitrile and ¹⁵N₂O. The higher activity of the bimetallic catalyst for the NO_x reduction reaction by toluene is discussed in the context of these partial oxidation intermediates.

Chemistry

Interactions of gold-based drugs with proteins: crystal structure of the adduct formed between ribonuclease A and a cytotoxic gold(III) compound

The reaction of Auoxo₆, a dinuclear gold(III) complex, with the model protein bovine pancreatic ribonuclease is explored and presented by Italian researchers using X-ray diffraction and ESI mass spectrometry (Metalomics, 2014, Advance Article, DOI: [10.1039/C3MT00265A](https://doi.org/10.1039/C3MT00265A)). Data provide clues on the processes of adduct formation and of enzyme inhibition and, inductively, on the likely mode of action of this metallodrug

Medicine

Spherical nucleic acid nanoparticle conjugates as an RNAi-based therapy for glioblastoma

Glioblastoma multiforme (GBM) is a neurologically debilitating disease that culminates in death 14 to 16 months after diagnosis. An incomplete understanding of how cataloged

genetic aberrations promote therapy resistance, combined with ineffective drug delivery to the central nervous system, has rendered GBM incurable. Functional genomics efforts have implicated several oncogenes in GBM pathogenesis but have rarely led to the implementation of targeted therapies. This is partly because many “undruggable” oncogenes cannot be targeted by small molecules or antibodies. Here, a team from Northwestern preclinically evaluate an RNA interference (RNAi)-based nanomedicine platform, based on spherical nucleic acid (SNA) nanoparticle conjugates, to neutralize oncogene expression in GBM (Jensen et al., Sci Transl Med 30 October 2013: Vol. 5, Issue 209, p. 209ra152). SNAs consist of gold nanoparticles covalently functionalized with densely packed, highly oriented small interfering RNA duplexes. In the absence of auxiliary transfection strategies or chemical modifications, SNAs efficiently entered primary and transformed glial cells in vitro. In vivo, the SNAs penetrated the blood–brain barrier and blood–tumor barrier to disseminate throughout xenogeneic glioma explants. SNAs targeting the oncoprotein Bcl2Like12 (Bcl2L12)—an effector caspase and p53 inhibitor overexpressed in GBM relative to normal brain and low-grade astrocytomas—were effective in knocking down endogenous *Bcl2L12* mRNA and protein levels and sensitized glioma cells toward therapy-induced apoptosis by enhancing effector caspase and p53 activity. Further, systemically delivered SNAs reduced *Bcl2L12* expression in intracerebral GBM, increased intratumoral apoptosis, and reduced tumor burden and progression in xenografted mice, without adverse side effects. Thus, silencing antiapoptotic signaling using SNAs represents a new approach for systemic RNAi therapy for GBM and possibly other lethal malignancies.

Ultrasensitive norovirus detection using DNA aptasensor technology

DNA aptamers were developed against murine norovirus (MNV) using Systematic Evolution of Ligands by EXponential enrichment (SELEX). Nine rounds of SELEX led to the discovery of AG3, a promising aptamer with very high affinity for MNV as well as for lab-synthesized capsids of a common human norovirus (HuNoV) outbreak strain (GII.3). Using fluorescence anisotropy, AG3 was found to bind with MNV with affinity in the low picomolar range. The aptamer could cross-react with HuNoV though it was selected against MNV. As compared to a nonspecific DNA control sequence, the norovirus-binding affinity of AG3 was about a million-fold higher. In further tests, the Canadian authors showed that the aptamer also showed nearly a million-fold higher affinity for the noroviruses than for the feline calicivirus (FCV), a virus similar in size and structure to noroviruses (Giamberardino et al., PloS One, DOI: [10.1371/journal.pone.0079087](https://doi.org/10.1371/journal.pone.0079087)). AG3 was incorporated into a simple

electrochemical sensor using a gold nanoparticle-modified screen-printed carbon electrode (GNPs-SPCE). The aptasensor could detect MNV with a limit of detection of approximately 180 virus particles, for possible on-site applications. The lead aptamer candidate and the aptasensor platform show promise for the rapid detection and identification of noroviruses in environmental and clinical samples.

Fine-tuning the antimicrobial profile of biocompatible gold nanoparticles by sequential surface functionalization using polyoxometalates and lysine

Antimicrobial action of nanomaterials is typically assigned to the nanomaterial composition, size and/or shape, whereas influence of complex corona stabilizing the nanoparticle surface is often neglected. Here, Australian researchers demonstrate sequential surface functionalization of tyrosine-reduced gold nanoparticles ($\text{AuNPs}^{\text{Tyr}}$) with polyoxometalates (POMs) and lysine to explore controlled chemical functionality-driven antimicrobial activity (Daima et al., PLoS ONE 8(10): e79676. doi:10.1371/journal.pone.0079676). The investigations reveal that highly biocompatible Au NPs can be tuned to be a strong antibacterial agent by fine-tuning their surface properties in a controllable manner. The observation from the antimicrobial studies on a gram negative bacterium *Escherichia coli* were further validated by investigating the anticancer properties of these stepwise surface-controlled materials against A549 human lung carcinoma cells, which showed a similar toxicity pattern. These studies highlight that the nanomaterial toxicity and biological applicability are strongly governed by their surface corona.

Incorporating gold into nanocrystalline silver dressings reduces grain boundary size and maintains suitable antimicrobial properties

Nanocrystalline silver dressings are widely known to be potent antimicrobial and anti-inflammatory agents and have long been used to treat topical wounds. Gold is known to be a strong anti-inflammatory agent and has been used in the treatment of rheumatoid arthritis for >70 years. The purpose of this work was to study the effect of incorporating gold into nanocrystalline silver dressings from antimicrobial and anti-inflammatory perspectives. Gold and silver dressing alloys were created by direct current magnetron sputtering and

compared with pure silver nanocrystalline dressings using conventional biological (log reduction and corrected zone of inhibition) and physical (X-ray diffraction, X-ray photoelectron spectroscopy, energy-dispersive X-ray spectroscopy, atomic absorption spectroscopy, atomic force microscopy, and scanning electron microscopy) characterization techniques (Unrau et al., International Wound Journal, Volume 10, Issue 6, pages 666–674, December 2013). While the gold/silver dressings were slightly weaker antimicrobials than the pure silver nanocrystalline structures, the addition of gold to the nanostructure reduces the minimum crystallite size from 17 to 4 nm. This difference increases the number of grain boundary atoms from 12 to 40 % which could augment the anti-inflammatory properties of the dressings. The formation of gold oxide (Au_2O_3) was thought to be responsible for the observed decrease in crystallite size.

Copper-64-alloyed gold nanoparticles for cancer imaging: improved radiolabel stability and diagnostic accuracy

Gold nanoparticles, especially positron-emitter-labeled gold nanostructures, have gained steadily increasing attention in biomedical applications. Of the radionuclides used for nanoparticle positron emission tomography imaging, radiometals such as ^{64}Cu have been widely employed. Currently, radiolabeling through macrocyclic chelators is the most commonly used strategy. However, the radiolabel stability may be a limiting factor for further translational research. Zhao et al. report the integration of ^{64}Cu into the structures of Au NPs (Angew. Chem. Int. Ed., DOI: 10.1002/ange.201308494). With this approach, the specific radioactivity of the alloyed Au NPs could be freely and precisely controlled by the addition of the precursor $^{64}\text{CuCl}_2$ to afford sensitive detection. The direct incorporation of ^{64}Cu into the lattice of the Au NP structure ensured the radiolabel stability for accurate localization in vivo. The superior pharmacokinetic and positron emission tomography imaging capabilities demonstrate high passive tumor targeting and contrast ratios in a mouse breast cancer model, as well as the great potential of this unique alloyed nanostructure for preclinical and translational imaging

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