

**Chemistry of gold(I, III) complexes with organic ligands as potential MOCVD precursors for fabrication of thin metallic films and nanoparticles**

BASOVA, T.V., HASSAN, Aseel <<http://orcid.org/0000-0002-7891-8087>> and MOROZOVA, N.B.

Available from Sheffield Hallam University Research Archive (SHURA) at:

<http://shura.shu.ac.uk/22435/>

---

This document is the author deposited version. You are advised to consult the publisher's version if you wish to cite from it.

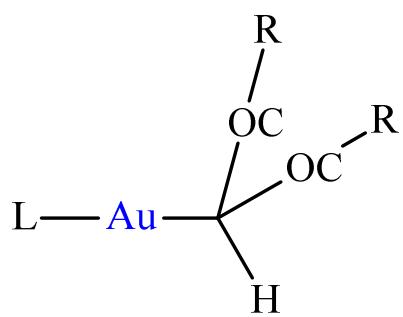
**Published version**

BASOVA, T.V., HASSAN, Aseel and MOROZOVA, N.B. (2018). Chemistry of gold(I, III) complexes with organic ligands as potential MOCVD precursors for fabrication of thin metallic films and nanoparticles. *Coordination Chemistry Reviews*, 380, 58-82.

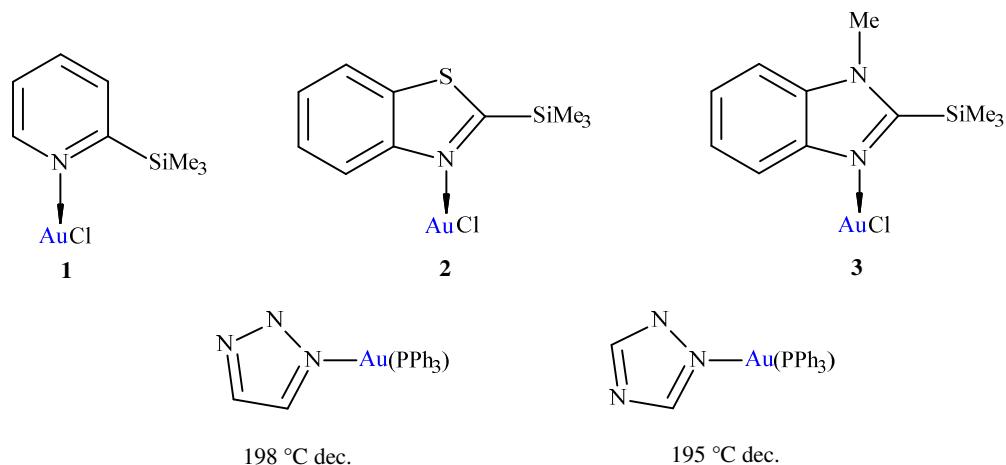
---

**Copyright and re-use policy**

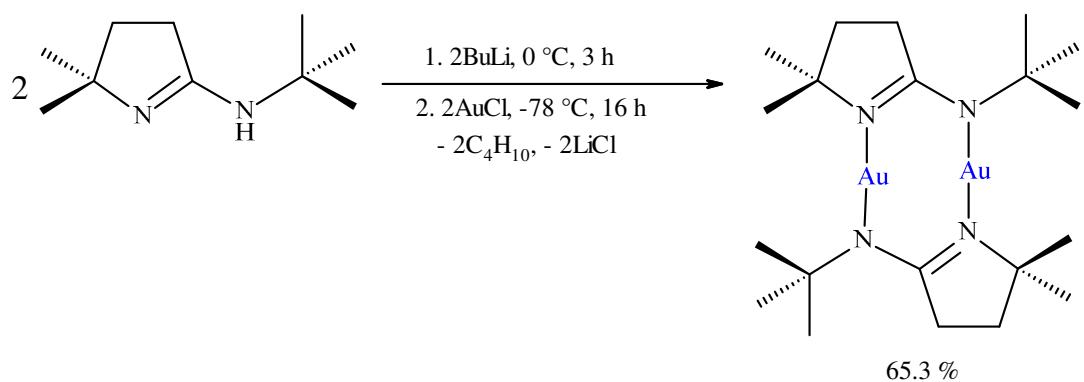
See <http://shura.shu.ac.uk/information.html>



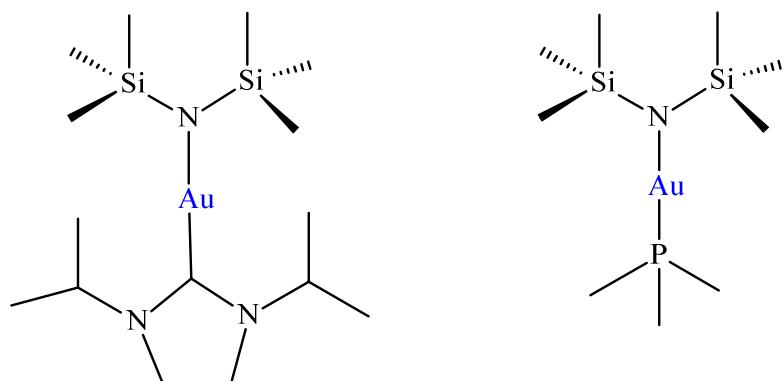
**Fig. 1.** Structure of gold(I)  $\beta$ -diketonates.



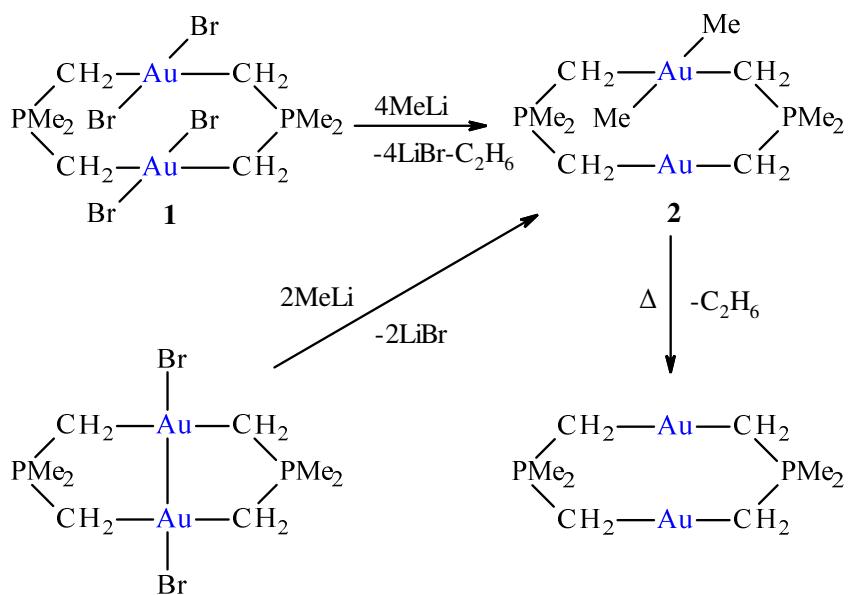
**Fig. 2.** Pyridine (**1**), benzothiazole (**2**) and benzoimidazole derivatives of gold chloride and complexes of (triphenylphosphine)gold with 1,2,3- and 1,2,4-triazole.



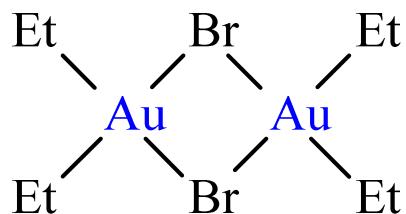
**Fig. 3.** Scheme of preparing gold(I) tert-butyl-imino-2,2-dimethylpyrrolidinate.



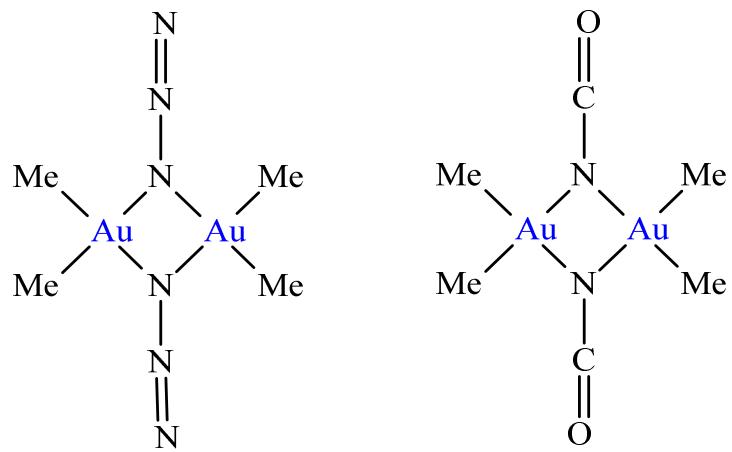
**Fig. 4.** Compounds  $\text{Au}(\text{HMDS})(\text{NHC})$  (**1**) and  $\text{Au}(\text{HMDS})(\text{PMe}_3)$  (**2**).



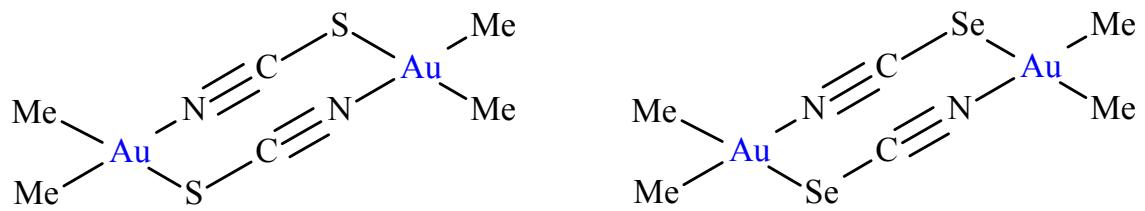
**Fig. 5.** The reactions of methylolithium with halogenated derivatives of dimer ylides.



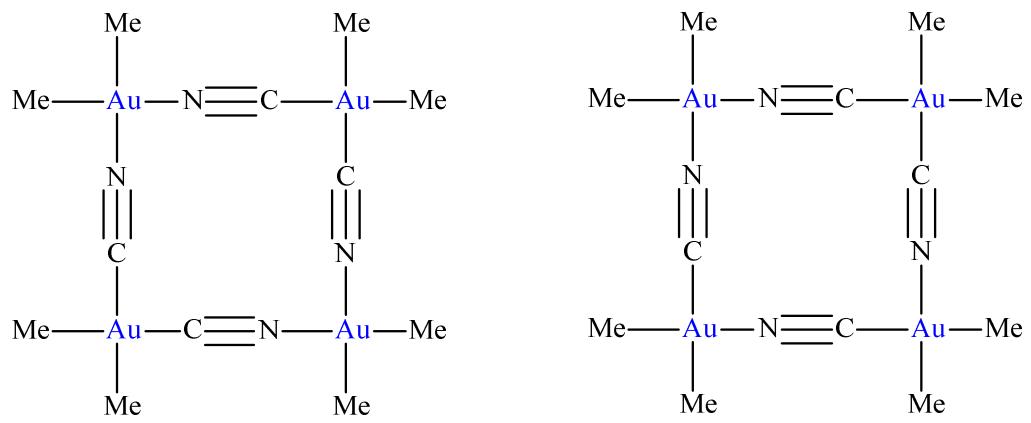
**Fig. 6.** Diethylgold(III) bromide.



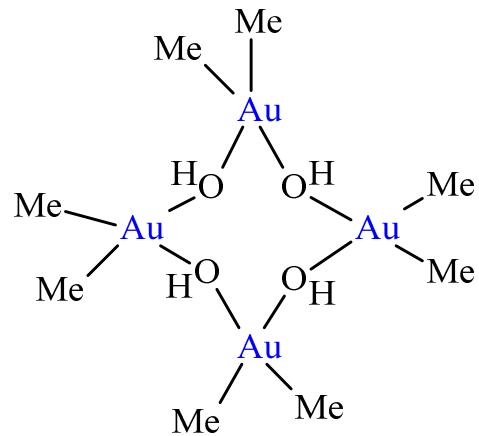
**Fig. 7.** Azide and cyanate of dimethylgold(III).



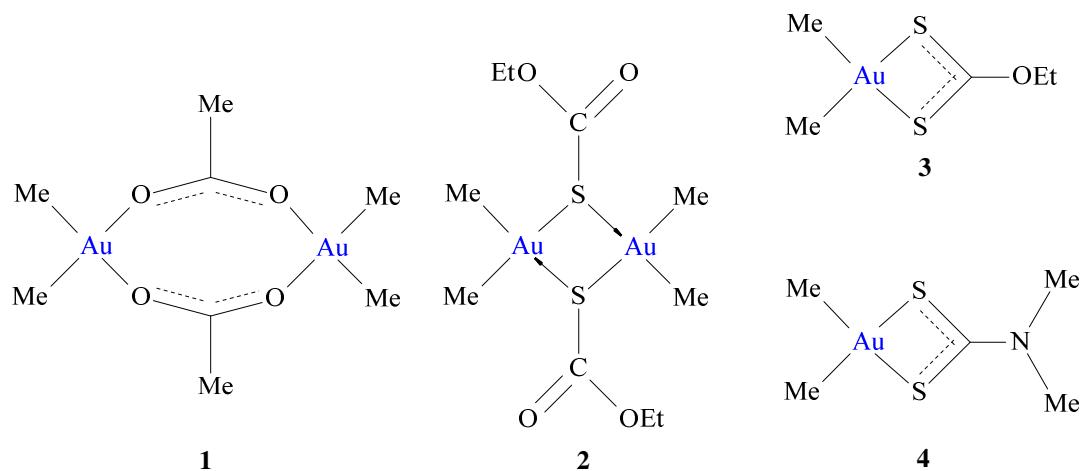
**Fig. 8.** Thio- and selenocyanate of dimethylgold(III).



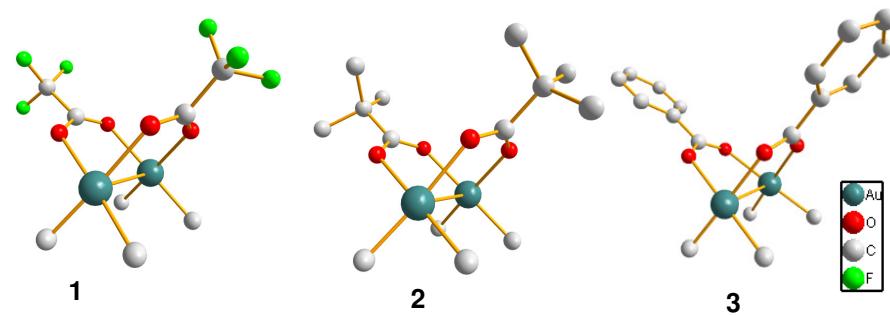
**Fig. 9.** Cyanides of dimethylgold(III).



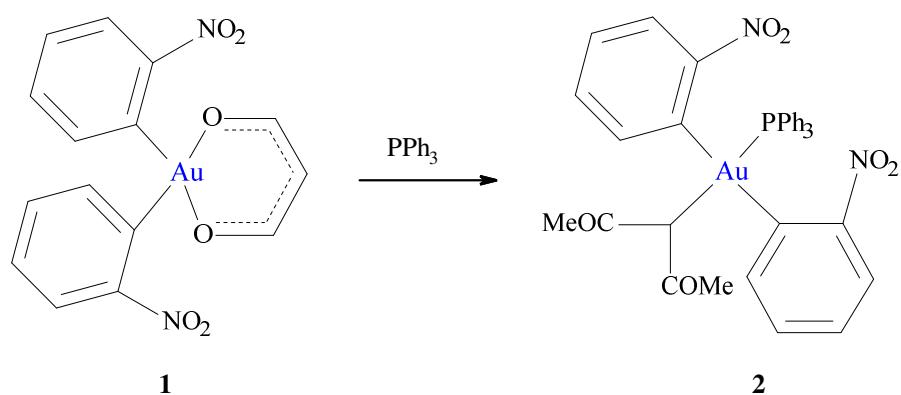
**Fig. 10.** Structure of dimethylgold(III) hydroxide.



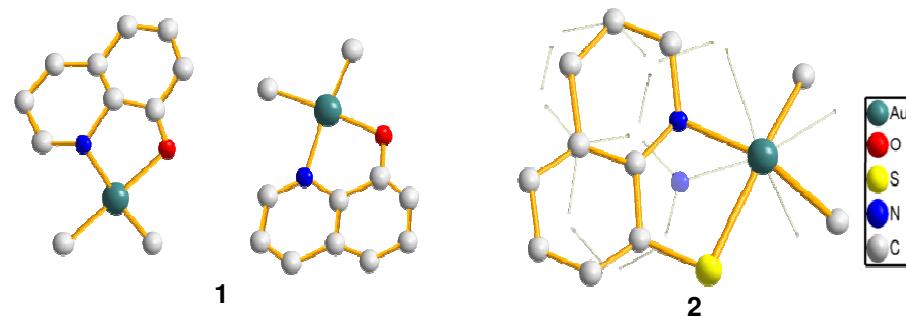
**Fig. 11.** Complexes of dimethylgold(III) with O- and S-donor ligands.



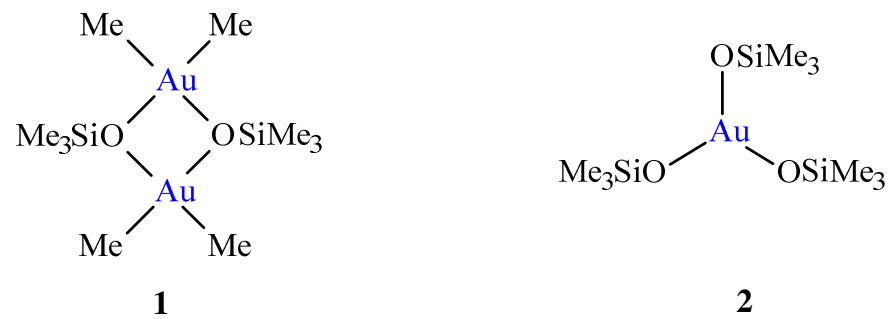
**Fig. 12.** Structure of dimethylgold(III) carboxylates  $[\text{Me}_2\text{Au}(\text{OOCR})_2]$  with  $\text{R} = \text{CF}_3$  (**1**), *t*- $\text{Bu}$  (**2**),  $\text{Ph}$  (**3**).



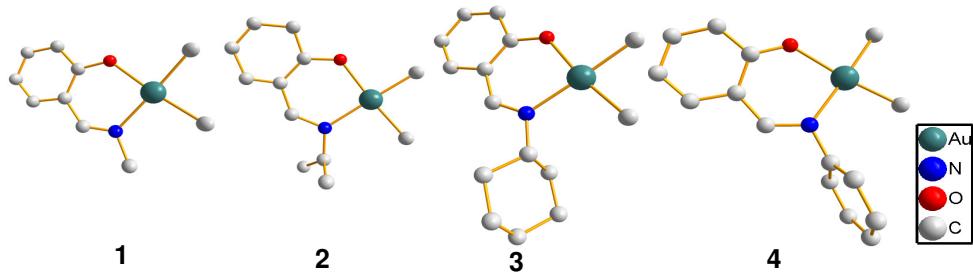
**Fig. 13.** The transformation of  $\beta$ -diketonates stabilized by orto-nitrobenzene radicals under the action of triphenylphosphine.



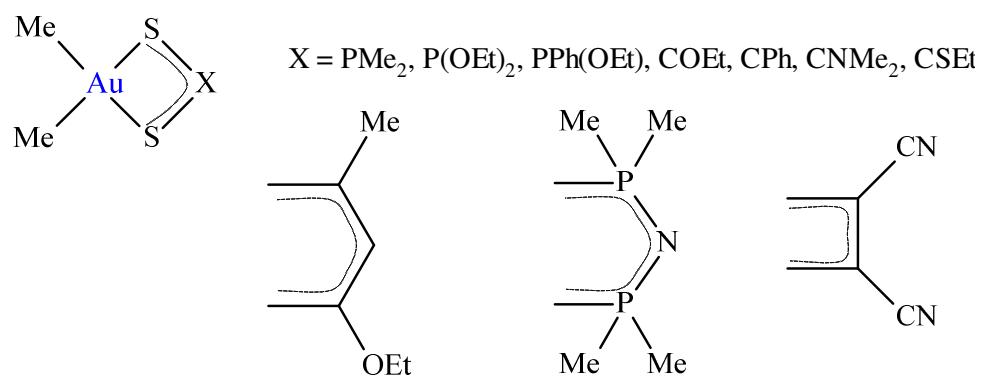
**Fig. 14.** Structure of  $\text{Me}_2\text{Au}(\text{ox})$  (**1**) and  $\text{Me}_2\text{Au}(\text{tox})$  (**2**).



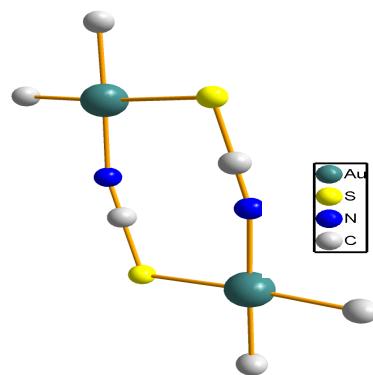
**Fig. 15.** Gold(III) complexes with trimethylsiloxy group.



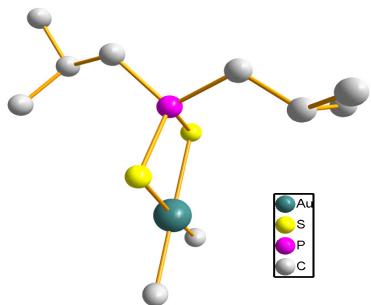
**Fig. 16.** Structures of  $\text{Me}_2\text{Au}(\text{Sal}=\text{NMe})$  (**1**),  $\text{Me}_2\text{Au}(\text{Sal}=\text{N}(i\text{-Pr}))$  (**2**),  $\text{Me}_2\text{Au}(\text{Sal}=\text{NCy})$  (**3**), and  $\text{Me}_2\text{Au}(\text{Sal}=\text{NPh})$  (**4**).



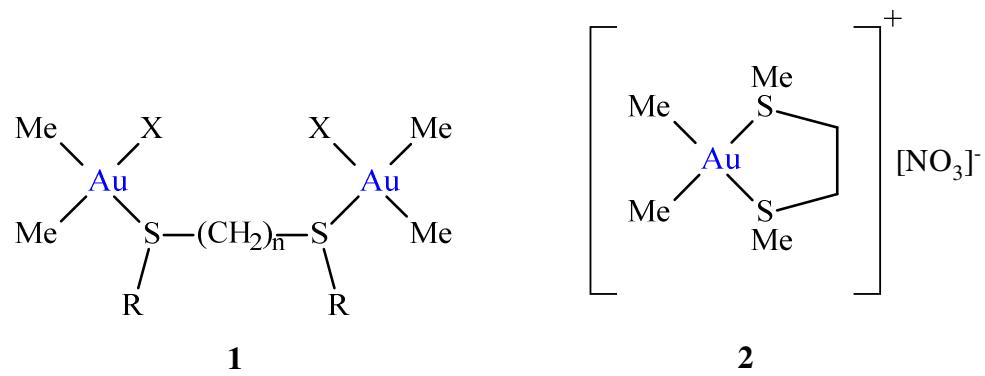
**Fig. 17.** Dimethylgold(III) compounds stabilized by S atom.



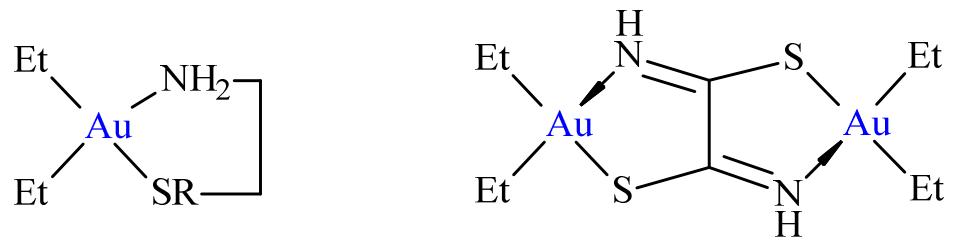
**Fig. 18.** Molecular structure of  $[\text{Me}_2\text{AuSCN}]_2$ .



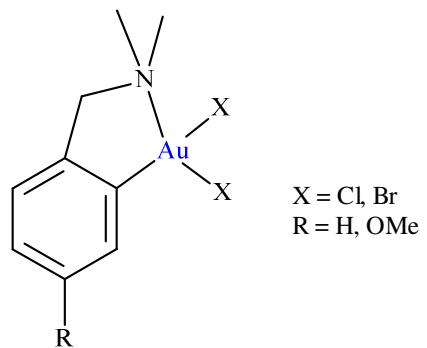
**Fig. 19.** Molecular structure of  $\text{Me}_2\text{AuS}_2\text{P}(i\text{-Bu})_2$ .



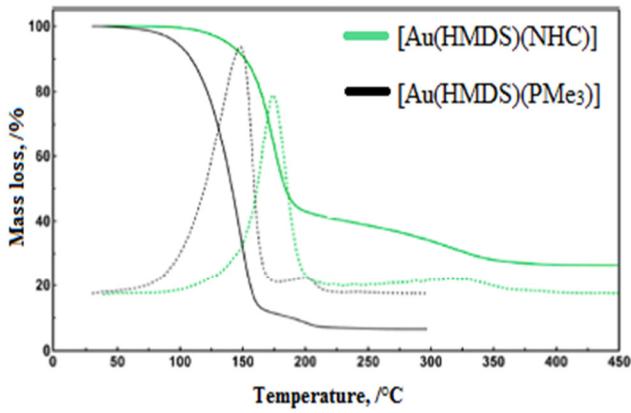
**Fig. 20.** Dimer (**1**) and monomer (**2**) thiocomplexes of dimethylgold(III).



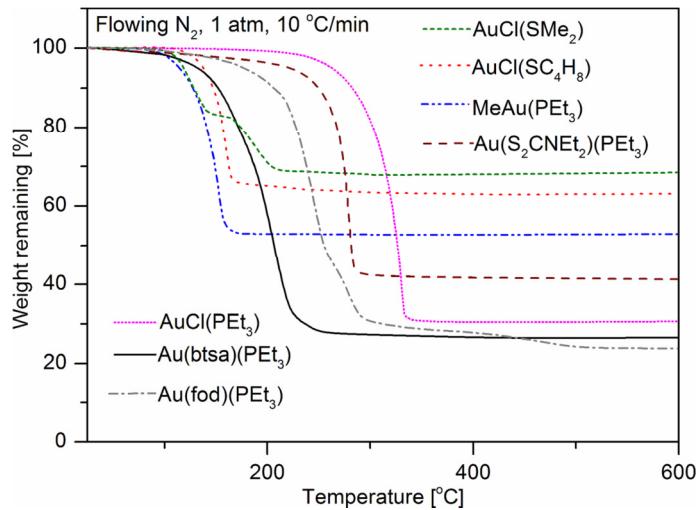
**Fig. 21.** Complexes of diethylgold(III) with N,S-coordination.



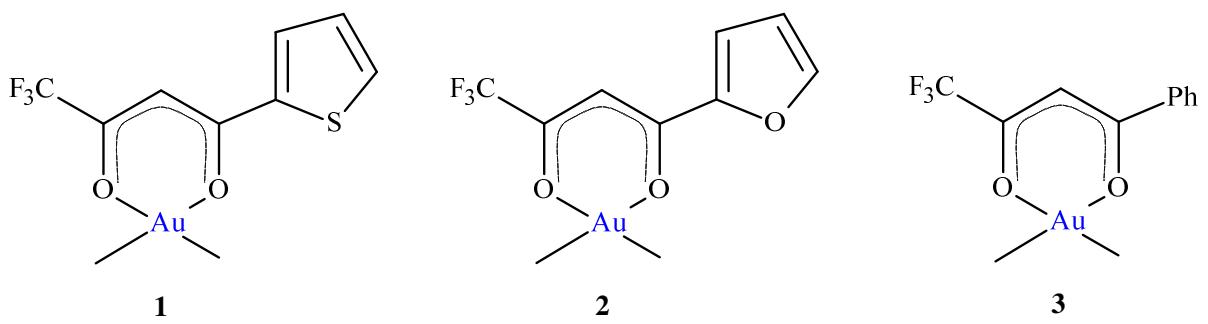
**Fig. 22.** Gold complexes with N,N-dimethylbenzylamine.



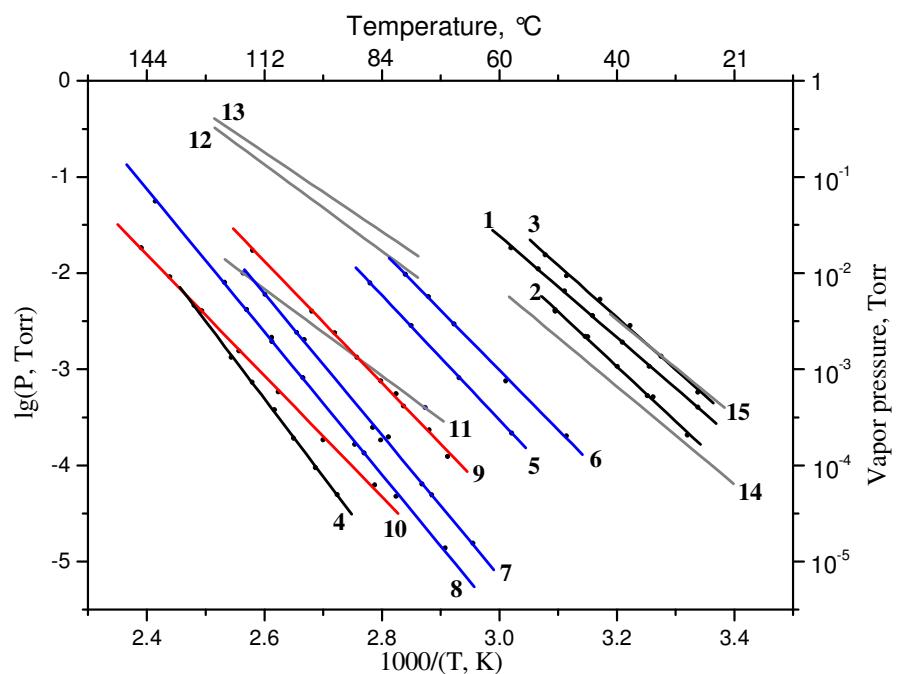
**Fig. 23.** TGA experiments of  $\text{Au}(\text{HMDS})(\text{NHC})$  (green) and  $\text{Au}(\text{HMDS})(\text{PMe}_3)$  (black) are shown as solid lines. Derivative curves are shown by dashed lines. Reprinted with permission from Ref. [85]. Copyright 2015 American Chemical Society.



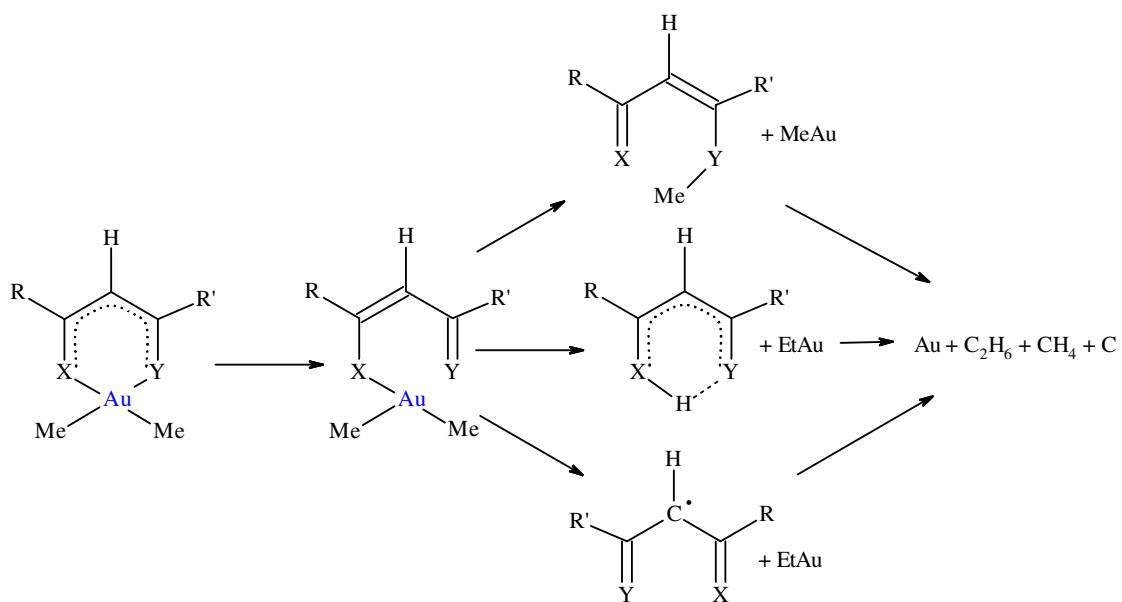
**Fig. 24.** TGA curves of Au compounds. Reprinted from Ref. [76] with permission from American Vacuum Society, Copyright 2017.



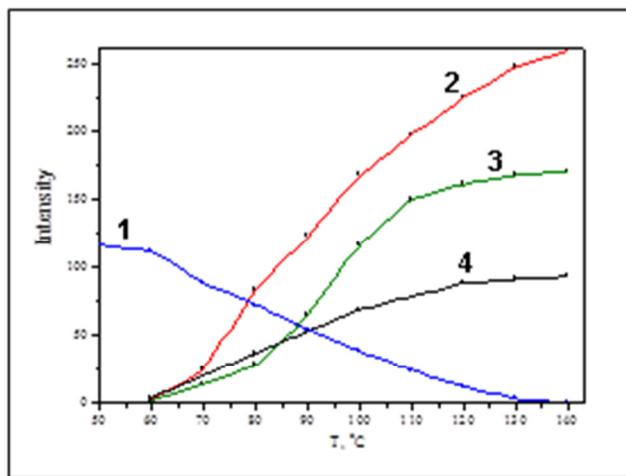
**Fig. 25.** Dimethylgold(III)  $\beta$ -diketonates:  $\text{Me}_2\text{Au}(\text{ttfac})$  (**1**) (ttfac - 1-(2-thienyl)-4,4,4-trifluoro-1,3-butanedionate),  $\text{Me}_2\text{Au}(\text{ftfac})$  (**2**) (ftfac - 1-(2-furanyl)-4,4,4-trifluoro-1,3-butanedionate),  $\text{Me}_2\text{Au}(\text{btfac})$  (**3**) (btfac - 1-phenyl-4,4,4-trifluoro-1,3-butanedionate).



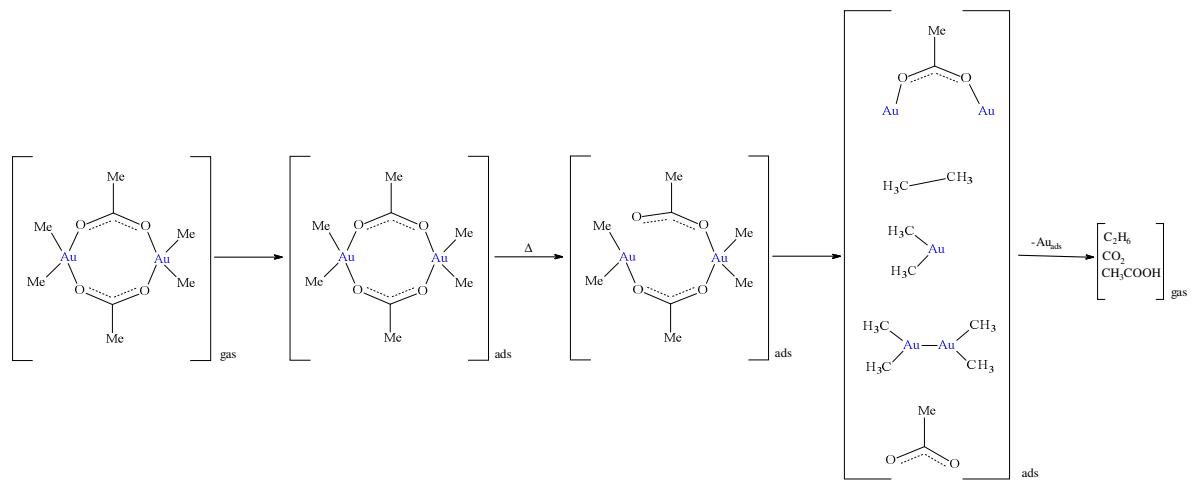
**Fig. 26.**  $P/T$  dependence for volatile complexes of dimethylgold(III) with organic ligands: **1** –  $[\text{Me}_2\text{Au}(\text{OAc})]_2$ ; **2** –  $[\text{Me}_2\text{Au}(\text{Piv})]_2$ ; **3** –  $[\text{Me}_2\text{Au}(\text{OOCCF}_3)]_2$ ; **4** –  $[\text{Me}_2\text{Au}(\text{OBz})]_2$ ; **5** –  $\text{Me}_2\text{Au}(\text{Sal}=\text{N}-\text{Me})$ ; **6** –  $\text{Me}_2\text{Au}(\text{Sal}=\text{N}-i\text{-Pr})$ ; **7** –  $\text{Me}_2\text{Au}(\text{Sal}=\text{N}-\text{Cy})$ ; **8** –  $\text{Me}_2\text{Au}(\text{Sal}=\text{N}-\text{Ph})$ ; **9** –  $\text{Me}_2\text{Au}(\text{OQ})$ ; **10** –  $\text{Me}_2\text{Au}(\text{SQ})$ ; **11** –  $\text{Me}_2\text{Au}(\text{bac})$ ; **12** –  $\text{Me}_2\text{Au}(\text{ttfac})$ ; **13** –  $\text{Me}_2\text{Au}(\text{btfac})$ ; **14** –  $\text{Me}_2\text{Au}(\text{i-acac})$ ; **15** –  $\text{Me}_2\text{Au}(\text{acac})$  [117, 138-140, 147-149].



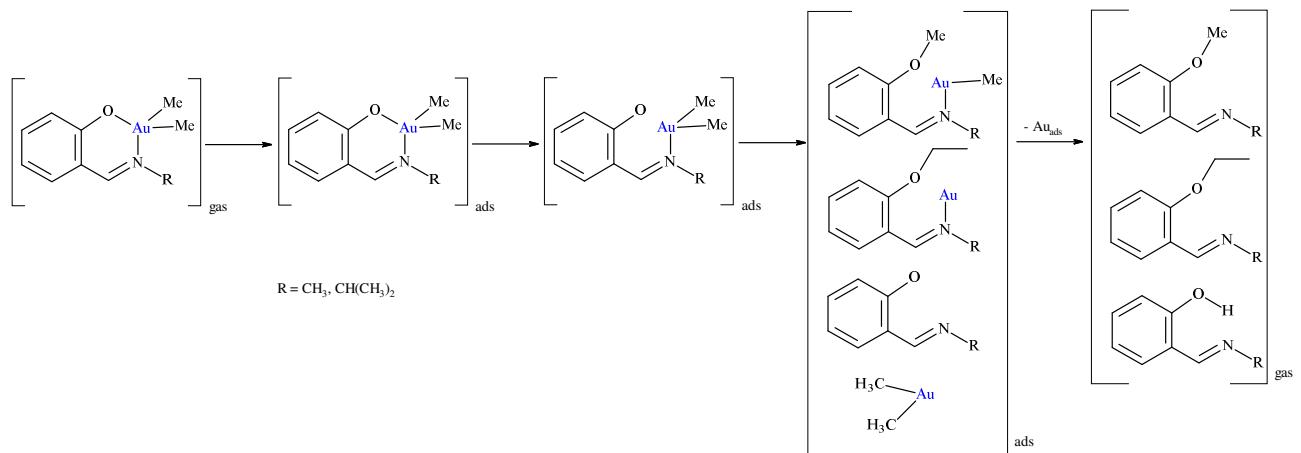
**Fig. 27.** Scheme of the thermolysis of dimethylgold(III) chelate vapors [112, 136].



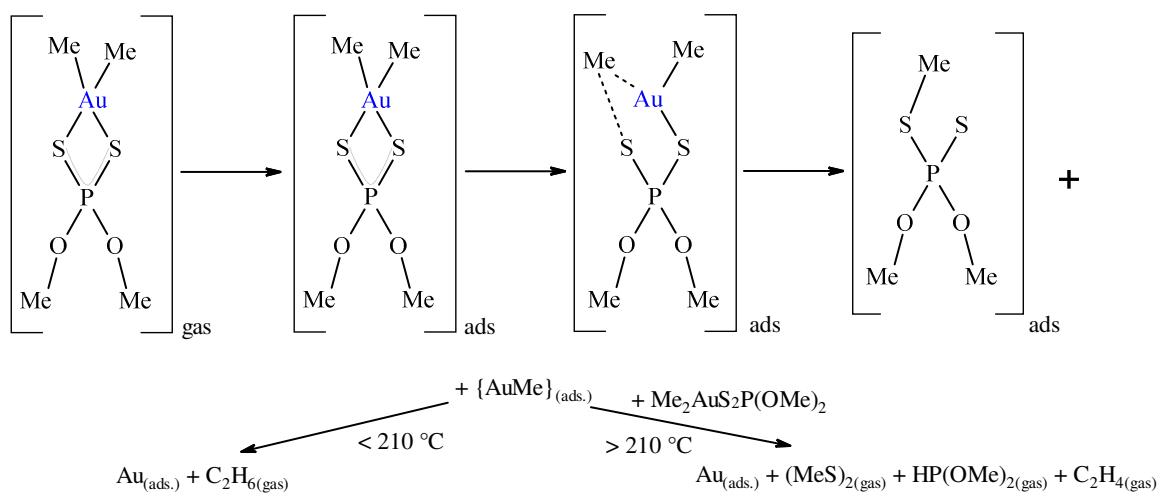
**Fig. 28.** Temperature dependence of the intensities of ion peaks of main gaseous products of thermal decomposition in the mass spectra of  $[\text{Me}_2\text{Au}(\text{OAc})]_2$ : (a) –  $[\text{Au}_2(\text{OOCCH}_3)]^+$ , (b) –  $[\text{COCH}_2]^+$ , (c) –  $[\text{OOCCH}_3]^+$ , (d) –  $[\text{C}_2\text{H}_6]^+$ . Adapted by permission from Ref. [139] Springer Customer Service Centre GmbH, Nature Springer, Copyright 2008.



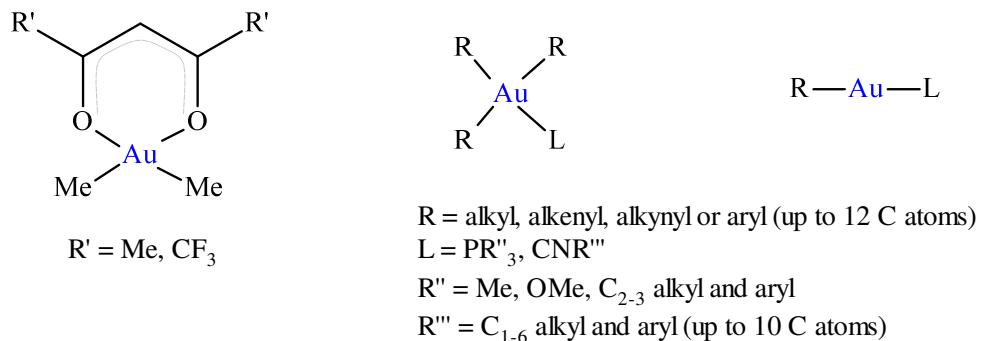
**Fig. 29.** Scheme of the chemical transformation of  $[\text{Me}_2\text{Au}(\text{OAc})]_2$  vapors on a heated surface in vacuum [138, 139].



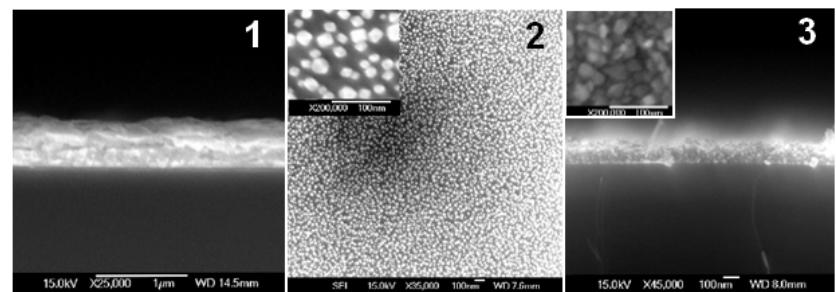
**Fig. 30.** Scheme of the chemical transformation of the vapors of dimethylgold(III) complexes with salicylaldimine on a heated surface in vacuum [117].



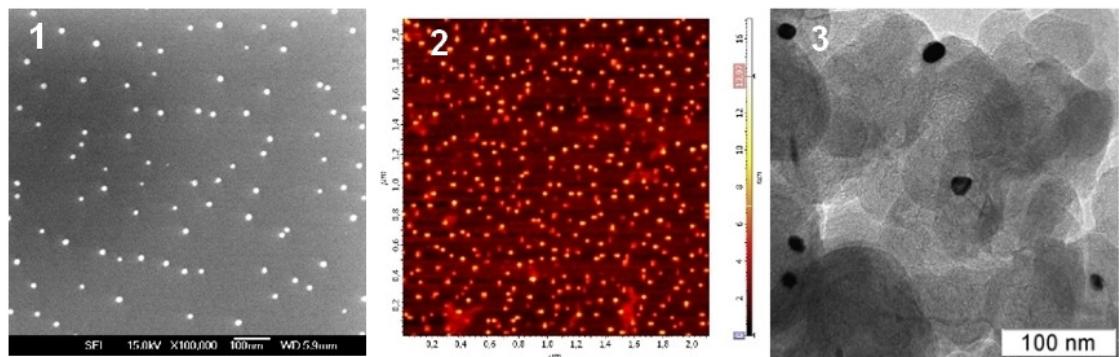
**Fig. 31.** Mechanism of thermal decomposition of  $\text{Me}_2\text{AuS}_2\text{P}(\text{OMe})_2$ .



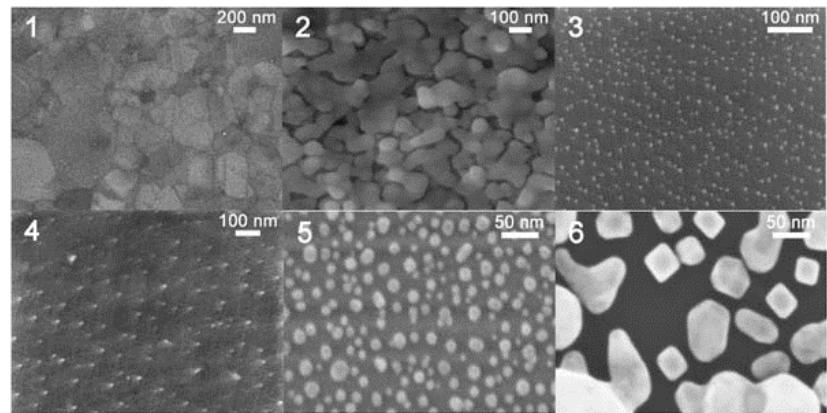
**Fig. 32.** Volatile gold complexes for CVD processes [93, 162].



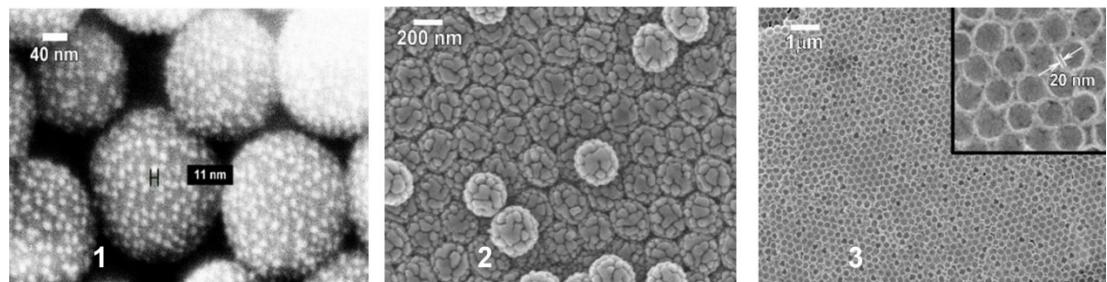
**Fig 33.** SEM images of gold coatings on Si(100) deposited using  $[\text{Me}_2\text{Au}(\text{OAc})_2$ ] (1),  $\text{Me}_2\text{Au}(\text{Sal}=\text{N}-\text{Me})$  (2) and  $\text{Me}_2\text{Au}(\text{Sal}=\text{N}-i\text{-Pr})$  (3) as precursors. Adapted from Ref. [138] with permission from Elsevier, Copyright 2007.



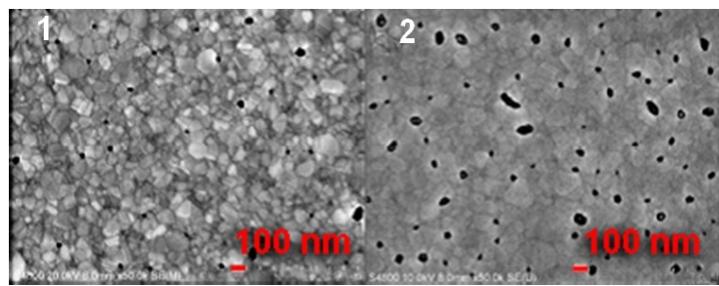
**Fig. 34.** SEM (1), AFM (2) and TEM (3) images of gold nanoparticles deposited by pulse-CVD on the surface of nanocarbon [171].



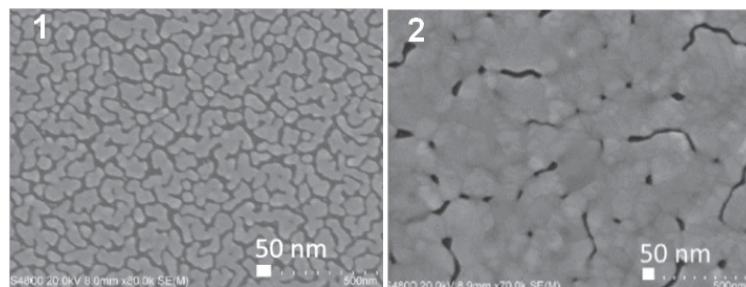
**Fig. 35.** SEM images of gold films and nanoparticles deposited under similar conditions from different precursors:  $[\text{Me}_2\text{Au}(\text{OAc})]_2$  (**1**),  $\text{Me}_2\text{Au}(\text{Piv})$  (**2**),  $\text{Me}_2\text{Au}(\text{OQ})$  (**3**),  $\text{Me}_2\text{Au}(\text{SQ})$  (**4**),  $\text{Me}_2\text{Au}(\text{thd})$  (**5**),  $\text{Me}_2\text{Au}(\text{S}_2\text{CNEt}_2)$  (**6**). Reprinted with permission from Ref. [172]. Copyright 2012 John Wiley and Sons.



**Fig. 36.** SEM images of gold nanoparticle (**1**) and thin films (**2**) deposited onto the matrix of photonic crystals as well as hollow gold nanoshells (**3**). Reprinted from Ref. [173] with permission from Elsevier, Copyright 2013.



**Fig. 37.** FESEM images of Au films deposited with 0.5 s (**1**) and 2 s (**2**)  $\text{Me}_2\text{Au}(\text{S}_2\text{CNEt}_2)$  pulses at  $180^\circ\text{C}$ . The  $\text{O}_3$  pulse was 1 s. Adapted with permission from Ref. [143]. Copyright (2017) American Chemical Society.



**Fig. 38.** FESEM images of Au thin films (**1**) and thick films (**2**). Reprinted from Ref. [76] with permission from American Vacuum Society, Copyright 2017.