

**Electronic Supplementary Information for:**

**Filamentous virus decoration with gold nanoparticles: Global fingerprints of bionanocomposites acquired with SERS**

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This supporting information presents:

- a) Electronic micrographs of aggregated wt fd virus with a AuNP at the tip end.
- b) Average standard Raman Spectra for wt fd virus and fd-cys virus.
- c) The principal features of SERS spectra obtained with PCA for the different kinds of viruses and synthesized nanobiocomposites.
- d) The assignment of functional groups to the relevant peaks in the spectra that were assigned based on standard databases for Raman spectra.<sup>1</sup>

## Notation

s, strong	vib, vibration	Aq. sln., aqueous solution
p, polarized	sym, symmetric	unsat, unsaturated
asym, asymmetric	vs, very strong	w, weak
str, stretching	def, deformation	v, variable
m, medium	sat, saturated	

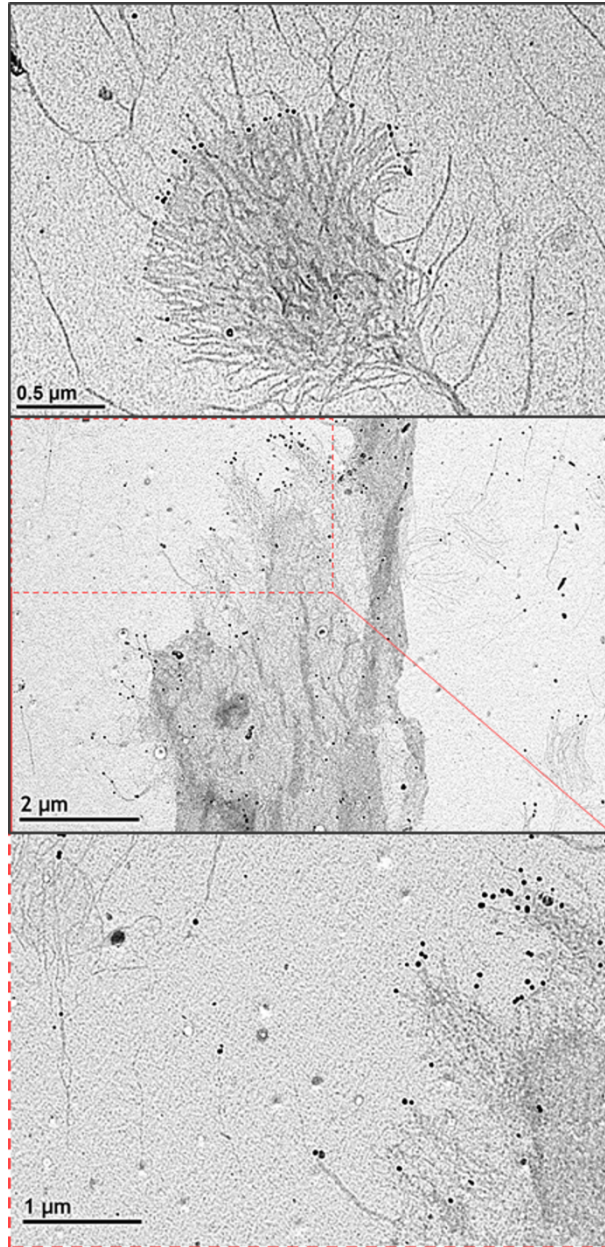


Fig S1 Electronic micrographs of aggregated wt fd virus with a AuNP at the tip end.

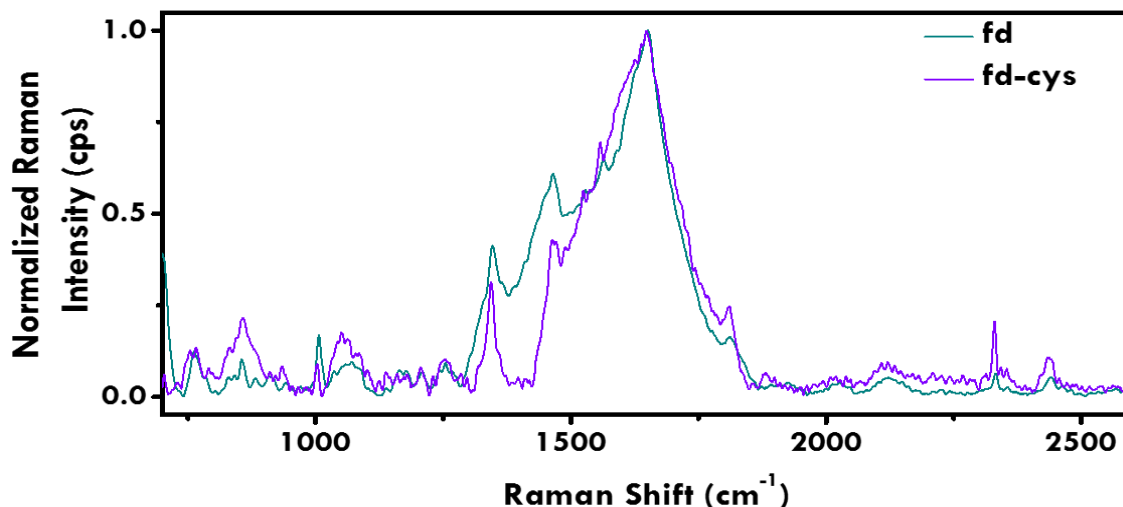


Fig. S2. Average standard Raman Spectra for wt fd virus and fd-cys virus. As it can be observed, both spectra are very similar.

Table S1. Principal differences between wt fd virus and fd-cys viruses obtained with principal component analysis.

Raman shift (cm <sup>-1</sup> )	Type of mode	Tentative functional groups assignment
721	<i>s, p</i> asym CNC str	tertiary amides
	P=S str	P=S
751	<i>s</i> , amide VII	primary thioamides
	<i>m, p</i> skeletal vib	branched alkanes
	<i>m-s, p</i> asym CSC str	CH <sub>3</sub> SCH <sub>2</sub> -
	<i>m, p</i> O-C=O in-plane def	formates
	<i>m-s</i> , C <sub>4</sub> O skeletal vib and CO def	tertiary alcohols
	<i>m-s</i> sym skeletal vib	tertiary butyl groups
889	<i>m-s, p</i> C-N str	saturated primary and secondary nitro compounds
	<i>m</i> , CH def	<i>cis</i> - CH=CH-
	<i>m-s</i> , skeletal vib	straight chain alkanes
	<i>m-s</i> , sym COC str	aliphatic ethers
	<i>s, p</i> CCO str	primary and secondary alcohols
952	<i>s, p</i> sym COC str	ethers
	<i>w</i> CH def	vinyl compounds -CH=CH <sub>2</sub>
	<i>vs</i> ring vib	polysubstituted pyridines
	<i>m-s, p</i> C-N str	saturated primary and secondary nitro compounds
1009	<i>m-s</i> , C=C, C=N str	pyrimidines
	<i>m-w</i> , P-H def	P-H
	<i>s, p</i> CH in -plane def	<i>ortho</i> disubstituted benzenes
	<i>s</i> , CH <sub>2</sub> /CH wagging vib	cyclopropil compounds
	<i>vs</i>	1,3,5-Trisubstituted benzenes
	<i>s, p</i> sym COC str	ethers
	<i>m-s</i> , C-C vib	-OC(CH <sub>3</sub> ) <sub>3</sub>
1057	<i>s, p</i> sym COC str	ethers
	<i>m-w</i> , P-H def	P-H

	<i>m-s</i> CCC str	straight chain alkanes
	<i>m</i> CO-C str	formates
	<i>s, p</i> CH in-plane def	orthodisubstituted benzenes
	<i>m-s</i> ring vib	2-monosubstituted pyridines
1082	<i>m-s</i> , C-N str	aliphatic amines
	<i>m-w</i> , P-H def	P-H
	<i>s, p</i> sym C=C=C str	allenes
	<i>m-s</i> , CCC str	straight chain alkanes
	<i>m-w</i> , <i>p</i> sym CNC str	saturated aliphatic ethers
	<i>s, p</i> sym COC str	ethers
	<i>s</i> , ring vib	ring =C-O-C=
1207	<i>s</i> , amide III band	trans secondary amides
	<i>s, p</i> N=N=N sym str	azides
	<i>s</i> , CH def	cis (sat) CH=CH (sat)
	<i>m</i> , CC <sub>3</sub> vib	t-butyl groups
	<i>m-w</i> , P=O str	P=O str
	<i>m-s</i> , C-N str	Aliphatic amines
	<i>m-s</i> C-O-O str	formates
1226	<i>m-s</i> , C-N str	aliphatic amines
	<i>m-w</i> , P=O str	P=O str
	<i>s</i> , CH def	<i>cis</i> (sat) CH=CH (sat)
	<i>m</i> , CC <sub>3</sub> vib	t-butyl groups
	<i>m-s</i> , ring vib	<i>p</i> -disubstituted benzenes
	<i>m-s</i> , CO-O str	acetates
1238	<i>s, p</i> N=N=N sym str	azides
	<i>s</i> , amide III band	trans secondary amides
	<i>s</i> , CH def	cis (sat) CH=CH (sat)
	<i>s, p</i> sym	nitrate -O-NO <sub>2</sub>
	<i>m</i> , CC <sub>3</sub> vib	t-butyl groups
1274	<i>s</i> , amide III	<i>trans</i> secondary amides
	<i>s, p</i> N=N=N sym str	azides
	<i>s</i> , CH def	<i>trans</i> (sat) CH=CH (sat) and <i>cis</i> (sat) CH=CH (sat)
	<i>m</i> , CC <sub>3</sub> vib	t-butyl groups
1330	<i>m-s, p</i> sym CO <sub>2</sub> <sup>-</sup> str	carboxylate ions
	<i>m-s</i> , CH in-plane rocking	aldehydes
	<i>m-w</i> , OH def	phenols
	<i>s-m</i> , asym N-C-N str	ureas
	<i>w</i> , CH in-plane def	=C=CH (hydrocarbons)
	<i>s</i> , C-N amide III band	cis form secondary amides
	<i>w</i> , sym CH <sub>3</sub> def	PCH <sub>3</sub>
	<i>s, p</i> N=N=N sym str	azides
1370	<i>s</i> , CH def	cis (sat) CH=CH (sat)
	<i>m-s</i> , CH in-plane rocking	aldehydes
	<i>m-s, p</i> sym CO <sub>2</sub> <sup>-</sup> str	aromatic acid salts and carboxylate ions
	<i>m-s, p</i> CH <sub>2</sub> def	vinyls-CH=CH <sub>2</sub>
1407	<i>s</i> , amide III band	primary thioamides
	<i>w</i> , asym CH <sub>3</sub> def	-PCH <sub>3</sub>
	<i>m-s</i> , CH in-plane rocking	aldehydes
	<i>m-s, p</i> sym CO <sub>2</sub> <sup>-</sup> str	aromatic acid salts and carboxylate ions
	<i>m-s, p</i> CH <sub>2</sub> def	vinyls-CH=CH <sub>2</sub>
1426	<i>m-w</i> , OCH <sub>3</sub> , OCH <sub>2</sub> def	-OCH <sub>3</sub> OCH <sub>2</sub> -
	<i>s, p</i> N=C=O sym str	isocyanates -N=C=O
	<i>w</i> , asym CH <sub>3</sub> def	-PCH <sub>3</sub>
	<i>m-s</i> , CH in-plane rocking	aldehydes
	<i>m-s, p</i> sym CO <sub>2</sub> <sup>-</sup> str	aromatic acid salts and carboxylate ions
	<i>m-s, p</i> CH <sub>2</sub> def	vinyls-CH=CH <sub>2</sub>

1467	<i>s</i> , amide III band	primary thioamides
	<i>m-w</i> , OCH <sub>3</sub> , CH <sub>2</sub> def	n-Alkanes
	<i>m-w</i> , CH <sub>2</sub> sym def	cyclopropyl compounds and POCH <sub>3</sub>
1516	<i>w</i> , NH def	secondary amines
	<i>m-w</i> , asym NO <sub>2</sub> str	aromatic nitro compounds
	<i>w</i> , NH <sub>3</sub> <sup>+</sup> sym def	-NH <sub>3</sub> <sup>+</sup>
1536	<i>w</i> , NH def	secondary amines
	<i>w</i> , amide II	ureas
	<i>w</i> , CO <sub>2</sub> <sup>-</sup> asym str	aromatic acid salts
1607	<i>s</i> , C=C str	C=C conjugated with C=C or C=O and <i>cis</i> (unsat) -CH=CH-unsat
	<i>w</i> , NH <sub>2</sub> scissoring	primary amines
	<i>m</i> , C=O str	enol from diketones
	<i>s</i> , several bands ring C=C str	benzene derivatives
	<i>w</i> , NH <sub>3</sub> <sup>+</sup> asym str	-NH <sub>3</sub> <sup>+</sup>
	<i>w</i> , CO <sub>2</sub> <sup>-</sup> asym str	aromatic acid salts
	<i>w</i> , amide III band	ureas
1624	<i>w-m</i> , amide I and II	primary and secondary amides
	<i>w</i> , NH <sub>2</sub> scissoring	primary amines
	<i>s</i> , C=C str	<i>trans</i> (unsat) -CH=CH-(unsat) and C=C conjugated with C=C, C=O or with aryl
	<i>s</i> , several bands ring C=C str	benzene derivatives
	<i>m</i> , C=O str	enol from diketones
	<i>w</i> , CO <sub>2</sub> <sup>-</sup> asym str	Carboxylic acid salts
1692	<i>w-m</i> , C=O str	α,β-unsat. aliphatic carboxylic acids (as dimer), aryl aldehydes, thiol acids, -COSH and α,β-unsat. ketones <i>s-cis</i> form
1767	<i>w-m</i> , C=O str	secondary amides
	<i>m, p</i> C=O str	Aryl and alfa, beta-unsat acid chlorides
1808	<i>m-w</i> , <i>p</i> C=O str	sat. Aliphatic acid chlorides and β, γ unsat γ-lactones (unsat 5 membered ring)
1925	<i>v</i> , asym C=C=C str	Allenes and symetrically disubstituted allenes
2010	<i>m-s, p</i> br, asym NCS str	isothiocyanates -N=C=S
2041	<i>m-s, p</i> br, asym NCS str	isothiocyanates -N=C=S
2086	<i>m-s, p</i> br, asym NCS str	isothiocyanates -N=C=S
2122	<i>v</i> , asym -N=C=C str	Ketenimines >C=N=N-
	<i>m-s, p</i> asym str	azides -N=N=N
	<i>v</i>	ketenes >C=C=O
2139	<i>v</i> , asym -N=C=C str	Ketenimines >C=N=N-
	<i>m-s, p</i> asym str	azides -N=N=N
2161	<i>v</i> , asym -N=C=C str	Ketenimines >C=N=N-
	<i>v</i>	ketenes >C=C=O
	<i>m-s, p</i> asym str	azides -N=N=N
	<i>m-s, p</i> br, asym NCS str	isothiocyanates -N=C=S
2211	<i>m-s</i> , CN str	P-CN
2275	<i>m-w</i> , P-H str	P-H
2292	<i>m-w</i> , P-H str	P-H
2335	<i>m-w</i> , P-H str	P-H
2361	<i>m-w</i> , P-H str	P-H
2373	<i>m-w</i> , P-H str	P-H
2479	<i>m-w</i> , P-H str	P-H
2494	<i>m-w</i> , P-H str	P-H
2517	<i>s, p</i> S-H str	<b>Meraptans, aliphatic thiols and thiophenols</b>
	<i>s, p</i> S-H str	<b>CH<sub>2</sub>SH</b>
2585	<i>s, p</i> S-H str	<b>Meraptans, aliphatic thiols, thiophenols and CH<sub>2</sub>SH</b>

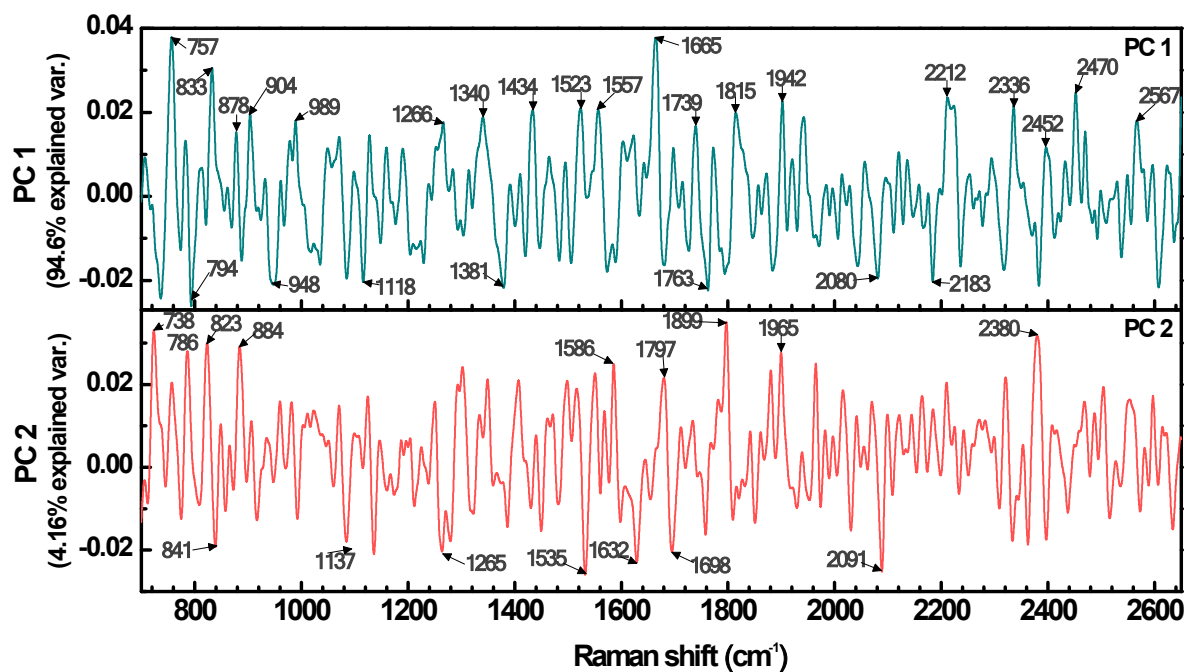


Fig. S3. The first and second principal components as given by PCA versus Raman shift when fd-cys-Au virus (nanowires-like) and the negative control (non-reduced fd-cys viruses plus AuNPs) SERS spectra are compared. Peaks with arrows correspond to the main differences between both spectra

Table S2. Modes and functional groups assignment for the principal differences between fd-cys-Au and negative control (non-reduced fd-cys plus AuNPs) obtained with PCA and pointed out in Fig.S3.

Raman shift (cm <sup>-1</sup> )	Type of mode	Tentative functional groups assignment
738	<i>s</i> , C-S str	aliphatic sulphides and disulphides
	<i>m</i> , NO <sub>2</sub> def	nitroamines N-NO <sub>2</sub>
	<i>m-s</i> , <i>p</i> asym CSC str	CH <sub>3</sub> SCH <sub>2</sub> -
	<i>m</i> , <i>p</i> O-C=O in-plane def	formates
	<i>m-s</i> , sym skeletal vib	tertiary butyl groups
757	<i>s</i> , <i>p</i> asym CNC str	tertiary amides
	<i>s</i> , amide I	thioamides
	<i>s</i> , amide VII	primary thioamides
	P=S str	P=S
	<i>m</i> , <i>p</i> skeletal vib	branched alkanes
	<i>m-s</i> , ring vib	<i>para</i> disubstituted benzenes
	<i>m-s</i> , <i>p</i> asym CSC str	CH <sub>3</sub> SCH <sub>2</sub> -
	<i>m</i> , <i>p</i> O-C=O in-plane def	formates
786	<i>m-s</i> , sym skeletal vib	tertiary butyl groups
	<i>s</i> , <i>p</i> asym CNC str	tertiary amides
	POP str	P-O-P
	P=S str	P=S
	<i>s</i> , amide I band	thioamides
	<i>m</i> , <i>p</i> skeletal vib	branched alkanes
	<i>m-s</i> , ring vib	<i>para</i> disubstituted benzenes
794	<i>m-s</i> , C <sub>4</sub> O skeletal vib and Co def	tertiary alcohols
	<i>s</i> , <i>p</i> asym CNC str	tertiary amides
	POP str	P-O-P
	P=S str	P=S
	<i>s</i> , amide I band	thioamides
	<i>m</i> , <i>p</i> skeletal vib	branched alkanes
823	<i>m-s</i> , C-S str	secondary thioamides
	<i>m-s</i> , skeletal vib	straight chain and branched alkanes
	<i>s</i> , <i>p</i> CCO str	primary and secondary alcohols
	<i>m-s</i> , sym COC str	aliphatic and vinyl ethers
	<i>s</i> , <i>p</i> asym CNC str	tertiary amides
	POP str	P-O-P
	P=S str	P=S
	<i>m-s</i> , ring vib	<i>para</i> disubstituted benzenes
833	<i>m-s</i> , C <sub>3</sub> O skeletal vib	secondary alcohols
	<i>m-s</i> , C-S str	secondary thioamides
	<i>s</i> , <i>p</i> asym CNC str	tertiary amides
	<i>s</i> , amide I	thioamides
	<i>s</i> , <i>p</i> CCO str	primary and secondary alcohols
	<i>m-s</i> , sym COC str	aliphatic and vinyl ethers
	POP str	P-O-P
	P=S str	P=S
	<i>m-s</i> , skeletal vib	straight and branched chain alkanes
841	<i>m-s</i> , C <sub>3</sub> O skeletal vib	secondary alcohols
	<i>m-s</i> , ring vib	<i>para</i> disubstituted benzenes
	<i>m-s</i> , C-S str	secondary thioamides
	<i>m-s</i> , skeletal vib	straight chain alkanes
	<i>s</i> , <i>p</i> CCO str	primary and secondary alcohols
	<i>m-s</i> , sym COC str	aliphatic and vinyl ethers
841	<i>s</i> , <i>p</i> asym CNC str	tertiary amides
	POP str	P-O-P



	P=S str	P=S
	<i>s</i> amide I band	thioamides
878	<i>m-s, p</i> C-N str	saturated primary and secondary nitro compounds
	<i>m-s, C-S</i> str	secondary thioamides
	<i>m, CH</i> def	<i>cis</i> CH=CH-
	<i>m-s, skeletal</i> vib	straight chain alkanes
	<i>s, p</i> CCO str	primary and secondary alcohols
	<i>m-s, sym</i> COC str	aliphatic ethers
884	<i>m-s, skeletal</i> vib	straight chain alkanes
	<i>s, p</i> CCO str	primary and secondary alcohols
	<i>m-s, sym</i> COC str	aliphatic ethers
	<i>m-s, p</i> C-N str	saturated primary and secondary nitro compounds
	<i>m, CH</i> def	<i>cis</i> CH=CH-
	<i>m-s, C-S</i> str	secondary thioamides
904	<i>m-s, p</i> C-N str	saturated primary and secondary nitro compounds
	<i>m, CH</i> def	<i>cis</i> CH=CH-
948	<i>s, p</i> sym COC str	ethers
	<i>vs</i> ring vib	polysubstituted pyridines
	<i>w</i> CH def	vinyl compounds -CH=CH <sub>2</sub>
989	<i>m-s, p</i> C-N str	saturated primary and secondary nitro compounds
	<i>m-s, C=C, C=N</i> str	pyrimidines
	<i>s, ring</i> vib	pyridines
	<i>m-w, P-H</i> def	P-H
	<i>s, p</i> sym COC str	ethers
	<i>s, CH<sub>2</sub>/CH</i> wagging vib	cyclopropyl compounds
	<i>m, CH</i> def	<i>trans</i> CH=CH- and <i>cis</i> CH=CH-
1118	<i>m-w, P=O</i> str	P=O str
	<i>m-s, C-N</i> str	Aliphatic amines
	<i>m-w, P-H</i> def	P-H
	<i>w, asym</i> C-O-C str	saturated aliphatic amines
	<i>s, p</i> sym COC str	ethers
	P-H	
1137	<i>m-w, P-H</i> def	
	<i>w, asym</i> C-O-C str	saturated aliphatic amines
	<i>s, p</i> sym COC str	ethers
1265	<i>s, amide</i> III	<i>trans</i> secondary amides
	<i>s, p</i> N=N=N sym str	azides
	<i>s, CH</i> def	<i>cis</i> (sat) CH=CH (sat)
	<i>m, CC<sub>3</sub></i> vib	t-butyl groups
1340	<i>s, C-N</i> amide III	<i>cis</i> form secondary amides
	<i>s-m, asym</i> N-C-N str	ureas
	<i>s, p</i> N=N=N sym str	azides
	<i>m-s, CH</i> in-plane rocking	aldehydes
	<i>m-s, p</i> sym CO <sub>2</sub> <sup>-</sup> str	carboxylate ions
	<i>m-w, OH</i> def	phenols
1381	<i>s, CH</i> def	<i>cis</i> (sat) CH=CH (sat)
	<i>s, amide</i> III band	primary thioamides
	<i>m-s, CH</i> in-plane rocking	aldehydes
	<i>m-s, p</i> sym CO <sub>2</sub> <sup>-</sup> str	aromatic acid salts and carboxylate ions
	<i>m-s, p</i> CH <sub>2</sub> def	vinyls-CH=CH <sub>2</sub>
1434	<i>s, amide</i> III	primary thioamides
	<i>m-s, CH</i> in-plane rocking	aldehydes
	<i>m-s, p</i> CH <sub>2</sub> def	vinyls-CH=CH <sub>2</sub>
	<i>m-w, OCH<sub>3</sub>, OCH<sub>2</sub></i> def	-OCH <sub>3</sub> OCH <sub>2</sub> -
	<i>m-s, p</i> sym CO <sub>2</sub> <sup>-</sup> str	aromatic acid salts and carboxylate ions
1523	<i>w, amide</i> III	ureas
	<i>w, NH</i> def	secondary amines
	<i>w, NH<sub>3</sub><sup>+</sup> sym</i> def	-NH <sub>3</sub> <sup>+</sup>
1557	<i>w, amide</i> III	ureas

	<i>w</i> , NH def	secondary amines
	<i>s</i> , several bands ring C=C str	benzene derivatives
1586	<i>w</i> , NH <sub>2</sub> scissoring	primary amines
	<i>m</i> , C=O str	enol from diketones
	<i>w</i> , NH <sub>3</sub> <sup>+</sup> asym str	-NH <sub>3</sub> <sup>+</sup>
	<i>w</i> , CO <sub>2</sub> <sup>-</sup> asym str	aromatic acid salts
	<i>w</i> amide III band	ureas
1632	<i>s-m</i> , asym NO <sub>2</sub> str	nitrates -ONO <sub>2</sub>
	<i>s</i> , C=C str	C=C conjugated with C=C or C=O or with aryl and <i>cis</i> (unsat) -CH=CH-unsat
	<i>w-m</i> , amides II	primary amides
	<i>w</i> , NH <sub>2</sub> scissoring	primary amines
	<i>m</i> , C=O str	enol from diketones
	<i>s</i> , several bands ring C=C str	benzene derivatives
1665	<i>w-m</i> , NH <sub>2</sub> def	primary amides
	<i>m-w</i> , amide I	Primary, secondary and tertiary amides
	<i>m-s</i> , C=N str	imines =C=N-
	<i>s</i> , C=C str	=C=C-N
	<i>s</i> , C=C str	<i>trans</i> (unsat)-CH=CH-(unsat)
	<i>m-w</i> , C=O str	α,β unsat ketones
1698	<i>w-m</i> , C=O str	α,β unsat Aliphatic carboxylic acids (as dimer), thiol acids, -COSH and secondary amides
	<i>v</i> , C=O str	aryl aldehydes
	<i>w</i> , C=O str	α,β-unsat ketones <i>cis</i> form
1739	<i>m</i> , C=O str	Sat. aliphatic esters, ketones and aldehydes and cationic α-amino acids
1763	<i>m-w</i> , C=O str	γ-lactones (sat 5-membered ring)
1797	<i>m-w</i> , C=O str	β lactones (4-membered ring) and sat. aliphatic acid chlorides
1815	<i>m-w</i> , C=O str	β lactones (4-membered ring)
1942	<i>v</i> , asym C=C=C str	Allenes and asymmetrically disubstituted allenes >C=C=CH <sub>2</sub>
1965	<i>v</i> , asym C=C=C str	Allenes and monosubstituted allenes >C=C=CH <sub>2</sub>
2080	<i>m-s</i> , <i>p</i> asym str	azides -N=N=N
2091	<i>m-s</i> , <i>p</i> br, asym NCS str	isothiocyanates -N=C=S
2183	<i>m-s</i> , <i>p</i> asym str	azides -N=N=N
2212	<i>s</i> , C=N str	aliphatic nitriles
	<i>m-s</i> , CN str	P-CN
2336	<i>m-w</i> , P-H str	P-H
2380	<i>m-w</i> , P-H str	P-H
2452	<i>m-w</i> , P-H str	P-H
2470	<i>m-w</i> , P-H str	P-H
2567	<i>s</i> , <i>p</i> S-H str	Mercaptans, aliphatic thiols, thiophenols and CH <sub>2</sub> SH

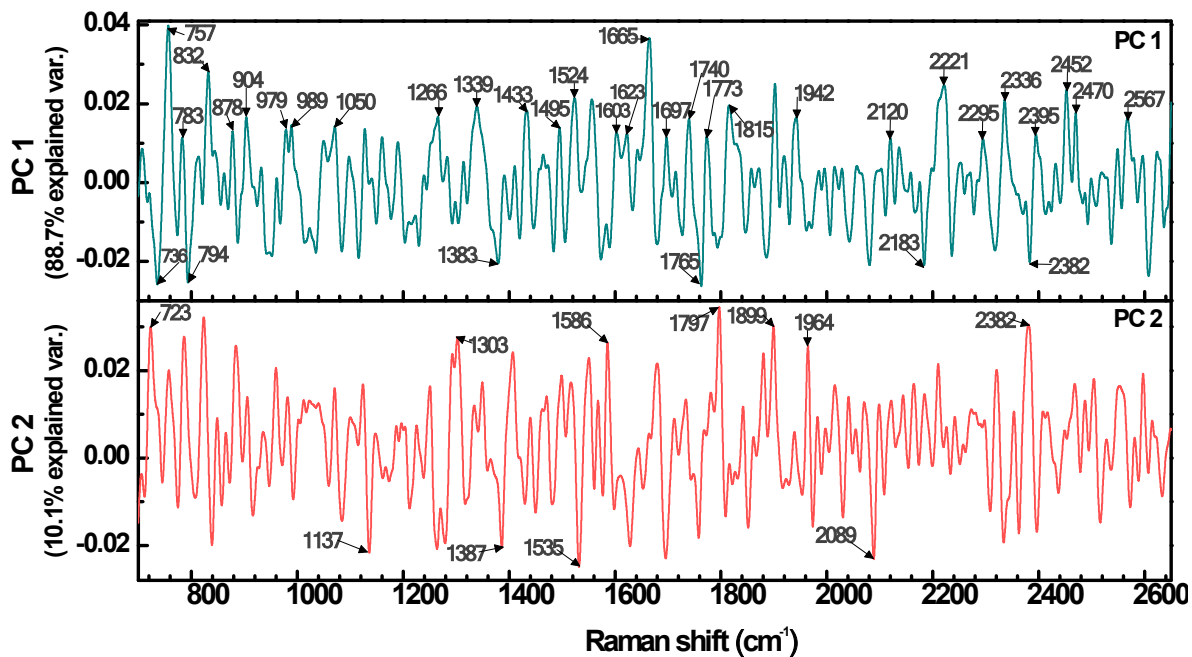


Fig. S4. The first and second principal components as given by PCA versus Raman shift when fd-cys-Au virus (nanowires-like) and fd-Au (AuNPs at the tip) SERS spectra are analyzed. Peaks with arrows correspond to the main differences between both spectra.

Table S3. Modes and functional groups assignment for the principal differences between fd-cys-Au (gold nanowire-like structures) and fd-Au (viruses with AuNPs at the tip) obtained with PCA and pointed out in Fig.S4.

Raman shift (cm <sup>-1</sup> )	Type of mode	Tentative functional groups assignment
723	<i>m-s, p</i> asym CSC str	CH <sub>3</sub> SCH <sub>2</sub> -
	<i>m, p</i> O-C=O in-plane def	formates
	<i>s</i> , amide VII	primary thioamides
	<i>m-s</i> , sym skeletal vib	tertiary butyl groups
	<i>s</i> , C-S str	aliphatic sulphides and disulphides
736	<i>m</i> , NO <sub>2</sub> def	nitroamines >N-NO <sub>2</sub>
	<i>m-s, p</i> asym CSC str	CH <sub>3</sub> SCH <sub>2</sub> -
	<i>m, p</i> O-C=O in-plane def	formates
	<i>m-s</i> sym skeletal vib	tertiary butyl groups
	<i>s</i> , C-S str	aliphatic sulphides and disulphides
757	<i>s, p</i> asym CNC str	tertiary amides
	P=S str	P=S
	<i>m, p</i> skeletal vib	branched alkanes
	<i>m-s</i> , ring vib	<i>para</i> disubstituted benzenes
	<i>m, p</i> CCl str	saturated aliphatic acid chlorides
	<i>m-s</i> , sym skeletal vib	tertiary butyl groups
	<i>m-s, p</i> asym CSC str	CH <sub>3</sub> SCH <sub>2</sub> -
783	<i>s, p</i> asym CNC str	tertiary amides
	P=S str	P=S
	POP str	P-O-P
	<i>m, p</i> skeletal vib	branched alkanes
	<i>m-s</i> , ring vib	<i>para</i> disubstituted benzenes
	<i>m-s</i> , CO def	tertiary alcohols
	794	<i>m-s</i> , CO skeletal vib and CO def
<i>s, p</i> asym CNC str		tertiary amides
POP str		P-O-P
P=S str		P=S
<i>m, p</i> skeletal vib		branched alkanes
832	<i>s, p</i> asym CNC str	tertiary amides
	POP str	P-O-P
	P=S str	P=S
	<i>m-s</i> , skeletal vib	Straight and branched chain alkanes
	<i>m-s</i> , sym COC str	Aliphatic and vinyl ethers
	<i>s, p</i> CCO str	primary and secondary alcohols
	<i>m-s</i> , ring vib	<i>para</i> disubstituted benzenes
878	<i>m-s, p</i> C-N str	saturated primary and secondary nitro compounds
	<i>m</i> , CH def	<i>cis</i> CH=CH-
	<i>m-s</i> , skeletal vib	straight chain alkanes
	<i>s, p</i> CCO str	primary and secondary alcohols
	<i>m-s</i> , sym COC str	aliphatic ethers
904	<i>m-s, p</i> C-N str	saturated primary and secondary nitro compounds
	<i>m</i> , CH def	<i>cis</i> CH=CH-
979	<i>s</i> , ring vib	pyridines
	<i>m-s, p</i> C-N str	saturated primary and secondary nitro compounds
	<i>m</i> , CH def	<i>trans</i> CH=CH- and <i>cis</i> CH=CH-
989	<i>m-s, p</i> C-N str	saturated primary and secondary nitro compounds
	<i>m-s</i> , C=C, C=N str	pyrimidines
	<i>s</i> , ring vib	pyridines
	<i>m-w</i> , P-H def	P-H
	<i>m</i> , CH def	<i>trans</i> CH=CH- and <i>cis</i> CH=CH-
	<i>s</i> , CH <sub>2</sub> /CH wagging vib	cyclopropyl compounds

	<i>s, p</i> sym COC str	ethers
1050	<i>m-s</i> , ring vib	2-monosubstituted pyridines
	<i>m-s</i> , CCC str	straight chain alkanes
	<i>s, p</i> CH in-plane def	orthodisubstituted benzenes
	<i>s, p</i> sym COC str	ethers
1071	<i>m</i> , CO-C str	formates
	<i>w</i> , asym C-O-C str	saturated aliphatic amines and ethers
	<i>m-s</i> , CCC str	straight chain alkanes
1128	<i>s, p</i> sym C=C=C str	allenes
	<i>m-s</i> , C-N str	-CO, NH, NH <sub>2</sub>
1137	<i>s, p</i> sym COC str	ethers
	<i>m-w</i> , P-H def	P-H
	<i>w</i> , asym C-O-C str	saturated aliphatic amines
1160	<i>s, p</i> sym COC str	ethers
	<i>m-s</i> , C-N str	Aliphatic amines
1190	<i>m-s</i> , C-N str	Aliphatic amines
	<i>s</i> , CH def	<i>cis</i> (sat) CH=CH (sat)
	<i>m</i> , CC <sub>3</sub> vib	t-butyl groups
	<i>m-s</i> , C-O-O str	formates
1266	<i>s</i> , amide III	<i>trans</i> secondary amides
	<i>s, p</i> N=N=N sym str	azides
	<i>s</i> , CH def	<i>cis</i> (sat) CH=CH (sat)
	<i>m</i> , CC <sub>3</sub> vib	t-butyl groups
1303	<i>v</i> , asym SO <sub>2</sub> str	sulphones
	<i>w</i> , sym CH <sub>3</sub> def	PCH <sub>3</sub>
	<i>s, p</i> N=N=N sym str	azides
1339	<i>s</i> , C-N amide III	<i>cis</i> form secondary amides
	<i>s-m</i> , asym N-C-N str	ureas
	<i>s, p</i> N=N=N sym str	azides
	<i>m-s</i> , CH in-plane rocking	aldehydes
	<i>m-s</i> , <i>p</i> sym CO <sub>2</sub> - str	carboxylate ions
1383	<i>s</i> , CH def	<i>cis</i> (sat) CH=CH (sat)
	<i>s</i> , amide III band	primary thioamides
	<i>s, p</i> N=C=O sym str	isocyanates -N=C=O
	<i>m-s</i> , CH in-plane rocking	aldehydes
	<i>m-s</i> , <i>p</i> sym CO <sub>2</sub> - str	aromatic acid salts and carboxylate ions
	<i>m-s</i> , <i>p</i> CH <sub>2</sub> def	vinyls-CH=CH <sub>2</sub>
1433	<i>m-s</i> , CH in-plane rocking	aldehydes
	<i>m-s</i> , <i>p</i> CH <sub>2</sub> def	vinyls-CH=CH <sub>2</sub>
	<i>m-s</i> , <i>p</i> sym CO <sub>2</sub> - str	aromatic acid salts and carboxylate ions
1495	<i>w</i> , NH def	secondary amines
	<i>w</i> , NH <sub>3</sub> <sup>+</sup> sym def	-NH <sub>3</sub> <sup>+</sup>
1524	<i>w</i> , amide III	ureas
	<i>w</i> , NH <sub>3</sub> <sup>+</sup> sym def	-NH <sub>3</sub> <sup>+</sup>
1535	<i>m-s</i> , <i>p</i> sym CO <sub>2</sub> - str	aromatic acid salts
	<i>w</i> , amide III band	ureas
	<i>w</i> , NH def	secondary amines
	<i>m-w</i> , asym NO <sub>2</sub> str	aromatic nitro compounds
1556	<i>w</i> , NH def	secondary amines
	<i>w</i> , amide III	ureas
	<i>s</i> , several bands ring C=C str	benzene derivatives
	<i>w</i> , NH <sub>2</sub> scissoring	primary amines
1586	<i>m</i> , C=O str	enol from diketones
	<i>w</i> , NH <sub>3</sub> <sup>+</sup> asym str	-NH <sub>3</sub> <sup>+</sup>
	<i>w</i> , CO <sub>2</sub> - asym str	aromatic acid salts
	<i>w</i> , NH <sub>2</sub> scissoring	primary amines
1603	<i>w</i> , NH <sub>3</sub> <sup>+</sup> asym str	-NH <sub>3</sub> <sup>+</sup>
	<i>s</i> , C=C str	C=C conjugated with C=C or C=O
	<i>s</i> , several bands ring C=C str	benzene derivatives

	<i>m</i> , C=O str	enol from diketones
1623	<i>w-m</i> , amides II	primary amides
	<i>w</i> , NH <sub>2</sub> scissoring	primary amines
	<i>w</i> , NH <sub>3</sub> <sup>+</sup> asym str	-NH <sub>3</sub> <sup>+</sup>
	<i>s</i> , C=C str	C=C conjugated with C=C, C=O or with aryl
	<i>m</i> , C=O str	enol from diketones
1665	<i>m-w</i> , amide I band	Primary, secondary and tertiary amides
	<i>w-m</i> , NH <sub>2</sub> def	primary amides
	<i>s, p</i> C=C str	=C=CH- and =C=C-N
	<i>m-w</i> , C=O str	α,β unsat ketones and ureas
1697	<i>w-m</i> , C=O str	α,β unsat. Aliphatic carboxylic acids (as dimer), aryl aldehydes, α,β-unsat ketones <i>s-cis</i> form and α,β-unsat dicarboxylic acids, thiol acids, -COSH, secondary amides
1740	<i>m</i> , C=O str	sat aliphatic esters, ketones and aldehydes and cationic α-amino acids (aq. sln.)
1765	<i>m-w, p</i> C=O str	aryl and a,b-unsat acid chlorides
	<i>m-w</i> , C=O str	γ-lactones (sat 5-membered ring)
1773	<i>m-w</i> , C=O str	γ-lactones (sat 5-membered ring)
1797	<i>m-w</i> , C=O str	β lactones (4-membered ring)
	<i>m-w, p</i> C=O str	sat. Aliphatic acid chlorides
1815	<i>m-w</i> , C=O str	β lactones (4-membered ring)
	<i>m-w, p</i> C=O str	sat. aliphatic acid chlorides
1942	<i>v</i> , asym C=C=C str	Allenes and asymmetrically disubstituted allenes =C=C=CH <sub>2</sub>
1964	<i>v</i> , asym C=C=C str	allenes and monosubstituted allenes >C=C=CH <sub>2</sub>
2089	<i>m-s, p</i> asym str	azides -N=N=N
2120	<i>v</i> , asym -N=C=C str	Ketenimines >C=N=N-
	<i>m-s, p</i> asym str	azides -N=N=N
2183	<i>m-s, p</i> asym str	azides -N=N=N
2221	<i>s</i> , C=N str	aliphatic nitriles
	<i>m-s</i> , CN str	P-CN
2295	<i>m-w</i> , P-H str	P-H
2336	<i>m-w</i> , P-H str	P-H
2382	<i>m-w</i> , P-H str	P-H
2395	<i>m-w</i> , P-H str	P-H
2452	<i>m-w</i> , P-H str	P-H
2470	<i>m-w</i> , P-H str	P-H
2567	<i>s, p</i> S-H str	Mercaptans, aliphatic thiols, thiophenols and CH <sub>2</sub> SH

## References

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