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XPS application for biologically related objects

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Ethylene glycol thiol and acidic thiol on Au surface

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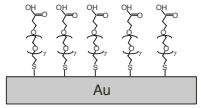
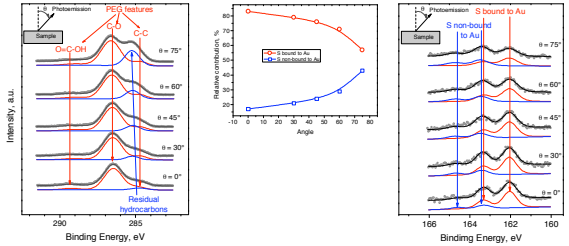
Organic thin films, especially self-assembled monolayers (SAMs), are commonly used to modify surfaces in order reduce immunogenic responses and make implantable materials more biocompatible. Polyethylene glycol (PEG) is one molecule that has been widely studied and shown to be able to reduce non specific protein adhesion and thereby improve biocompatibility.

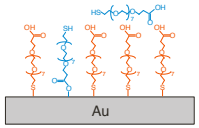
- How PEG is able to reduce non specific protein adhesion
- How to properly create a PEG SAM with the correct distribution and arrangement.



Angle Resolved XPS



In ideal PEG self-assembled monolayer: θ = 1 ML

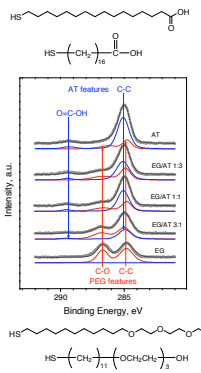


Based on oxygen: θ = 0.68 ML
Based on carbon: θ = 0.78 ML
Based on sulfur: θ = 0.56 ML

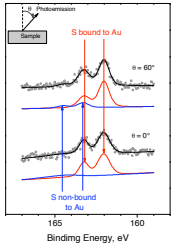
The cleaned gold substrates were then immersed into 0.01 M thiolated polyethylene glycol (PEG) acid ($HSC_2H_4(OC_2H_4)_8COOH$) in ethanol.

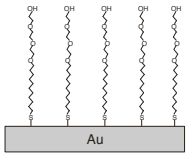
XPS conclusions on PEG SAM
- Residual hydrocarbon;
- Non-ideal adsorption: not complete monolayer and upside-down configuration.

Co-adsorption of EG thiol and acidic thiol



Solution	EG %	AT %
AT	21.14	78.86
EG/AT 1:3	44.54	55.46
EG/AT 1:1	38.60	61.40
EG/AT 3:1	70.48	29.52
EG	100	0





EG thiol:
Based on carbon: θ = 0.9 ML
Based on sulfur: θ = 0.6 ML
Height: 23.6Å (18.5 atomic bonds)

XPS conclusions on co-adsorbed EG and AT
- EG thiol forms the bond with Au through sulfur
- Coverage of EG layer is close to ideal
- AT layer contains up-side down configuration: sulfur group does not attached to Au

Sol-Gels Modified with Covalently Bound Peptides

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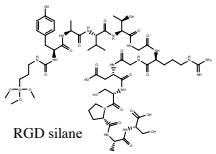
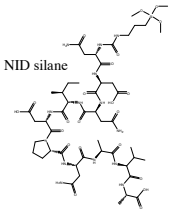
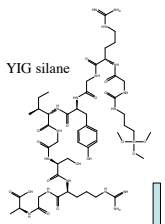
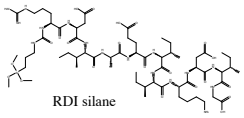
The integration of differentiated neurons into engineered devices has a high potential in implant biomedicine and cell-based biosensor application. This requires that cells must adhere on inorganic or hybrid materials and carry out normal metabolism, proliferation and differentiation. Sol-gel derived materials produced under biologically benign conditions have recently demonstrated high ability as substrates for adherent mammalian cells. The RGD and YIGSR peptides were also used to promote cellular adhesion, a phenomenon of crucial importance in the case of substrates for tissue engineering.



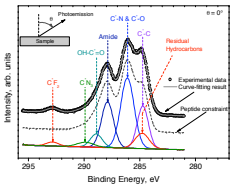






XPS of powder peptides

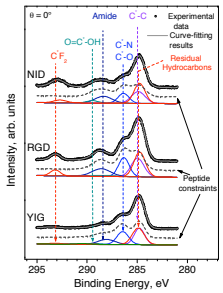
The C 1s spectrum obtained from the powder RGD peptide at 0° collection angle.



The number of carbon atoms in the different position and expected BE range (free peptides/peptide-silanes)

	C*-C Type 1	C*-N Type 2	C*-O Type 3	O=C*-N (amide) Type 4	O=C*-OH (carboxyl) Type 5	C*-N_3 Type 6
Binding Energy expected, eV	284.6-285	285.5-286.5	286.4-287	287.4-288.4	288.5-289.6	289.0-289.5
NID silane	18	12	-	13	3	-
RDI silane	20	13	7	12	2	1
RGD silane	20	13	7	18	2	1
YIG free peptide	18	14	2	9	1	1

XPS of surface peptides



The C 1s spectra obtained from surface YIG, RGD, NID silanes.

Oxygen to carbon and nitrogen to carbon ratios measured by XPS and expected from the surface peptide silane structure.

	C_{total} / $C_{peptide}$ at %	$N/C_{peptide}$ Ideal/XPS	$O/C_{peptide}$ Ideal/XPS
NID silane	10.2 / 5.3	0.286 / 0.239	0.449 / 3.206
RDI silane	17.7 / 11.1	0.262 / 0.272	0.361 / 1.229
RGD silane	19.0±1.6 / 10.8±1.4	0.308 / 0.322±0.0076	0.423 / 4.828±0.839
YIG silane	13.3.0±0.4 / 6.2±0.4	0.292 / 0.238±0.033	0.333 / 1.639±0.0115

Coverage and adlayer height estimations

	Height, Å	Coverage, Molecules per Si atoms on the surface
NID silane	11.0	0.09
RDI silane	31.3	0.15
RGD silane	19.5	0.17
YIG silane	5.8	0.08

XPS conclusions on Sol-Gels Modified with Covalently Bound Peptides:
- XPS is a new reliable tool for the characterization of organic thing film
- Peptides and proteins can be quantified; the film quality can be examined