Amphiphilic carbohydrate–phthalocyanine conjugates obtained by glycosylation or by azide–alkyne click reaction†

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Two series of amphiphilic carbohydrate–phthalocyanine conjugates have been prepared either by glycosylation or by copper-catalyzed click coupling. A common precursor, a hydroxylated phthalocyanine, was directly glycosylated or converted into an azido derivative before undergoing grafting of propargyl–carbohydrates by click reaction.

Introduction

Phthalocyanines (Pcs) bearing carbohydrates are interesting compounds, since the presence of carbohydrate moieties could increase the water-solubility of the phthalocyanines or give them amphiphilic properties. Since the first one described in 1989 by Maillard *et al.*,[1a] only a few examples of sugar-bearing phthalocyanines have been reported in the literature, with an increasing interest for such compounds from 2005.[1b–p] The common targeted application was their use as photosensitizers, taking advantage of the water solubilizing properties and of the innocuousness of carbohydrates. It must be noted that the removal of carbohydrate's protecting groups appeared to not be mandatory to obtain satisfactory Photodynamic Therapy (PDT) efficacy.[1a,f] Enhancement of the amphiphilicity of the phthalocyanine with the introduction of hydrophobic chains proved to increase the cell penetration.[1a,f]

From a synthetic point of view, most of the phthalocyanines linked to carbohydrates reported so far are mixtures of positional isomers (when the phthalocyanine macrocycle is tetrasubstituted) and of anomers. The sugar units were introduced on phthalocyanine precursors (phthalonitriles) or axially on preformed Si(IV) phthalocyanines. Direct grafting on phthalonitriles was achieved by classical nucleophilic substitution of one hydroxyl group of a carbohydrate on 3- and 4-nitrophthalonitrile (in the case of the hydroxyl group of 1,2:5,6-di-*O*-isopropylidene-α-D-glucofuranose[1a] and 1,2:3,4-di-*O*-isopropylidene-α-D-galactopyranose[1f]) or on di-[1o] or tetrafluoro phthalonitrile[1c] (the two or four fluorine atoms being substituted by the same galactose derivative). These carbohydrate-linked phthalonitriles underwent homo or hetero cyclotetramerisation with eventual cleavage of the sugar protecting groups. Similar nucleophilic substitution of the chlorine atoms of Cl_2SiPcs by the primary hydroxyl group of 1,2:3,4-di-*O*-isopropylidene-α-D-galactopyranose led to axially mono- or bis-carbohydrate-substituted phthalocyanines.[1b] These products exhibit a high photodynamic activity against HepG2 human hepatocarcinoma cells, although the acetal groups were not cleaved. 3-*O*-(11-Hydroxy-3,6,9-trioxaundecyl)-1,2:5,6-di-*O*-isopropylidene-α-D-glucofuranose (tetraethyleneglycol monosubstituted by a protected glucofuranose) performed comparable axial substitution.[1h] The carbohydrate units may as well be grafted on a spacer connecting it to the phthalocyanine macrocycle, with a comparison of the influence of the number and position of the substituents.[1n]

The first phthalocyanine bearing carbohydrates linked to the macrocycle *via* a glycosidic bond was described in 2006.[1e] Hanack and Ziegler used a common reaction in phthalocyanine chemistry, the nitrite displacement on 4-nitrophthalonitrile[1d] by an alcoholate, and applied it first on glucose, then to various carbohydrates,[1g] developing a new glycosylation method for the preparation of protected 3,4-dicyanophenyl D-glycopyranosides. The per-*O*-benzylated glycosides could be transformed into the desired phthalocyanines by reaction with zinc acetate in dimethylaminoethanol at 150 °C. However, cleavage of the benzyl groups was unsuccessful. Since the conditions required for the phthalocyanine formation were too harsh for per-*O*-acylated glycosides, these compounds were first de-*O*-acylated and the products were directly transformed into tetraglycosylated phthalocyanines under smoother conditions: reaction at 100 °C with zinc acetate in a 2 : 1 diaminoethanol/n-butanol mixture. This was the first example of peripherally glucose-substituted Zn(II) phthalocyanines linked *via* the anomeric carbon. The same method was applied by us to obtain a tetra galactose-substituted Zn(II) phthalocyanine whose PDT efficacy has been tested.[1i] Recently, similar octacarbohydrate-substituted phthalocyanines have been concomitantly reported,[1l,m] ending the characterization problems met with mixtures of positional isomers. Tetragalactose-substituted naphthalocyanines are described as well.[1p] Finally, the synthesis of phthalocyanine-linked cytidine[2] and phthalocyanine-linked *C*-ribofuranosyl[3] derivatives *via* Sonogashira coupling reaction must also be mentioned.

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† Dedicated to Dr Paul Boullanger, on the occasion of his retirement.

Click reactions are very simple reactions, easy to handle and give products regiospecifically and in high yields.[4] The general concept of click chemistry was initially formulated by Sharpless *et al.*[5] in 2001, describing a chemistry tailored to generate products quickly by joining small units together with high yields and in a very simple manner, as occurring in biological systems. This concept includes various reactions such as cycloadditions, nucleophilic ring opening, non-aldol carbonyl chemistry, addition to carbon–carbon multibonds, *etc*... and has become an essential part of current chemistry: during the year 2007, more than three hundred fifty publications about click chemistry have been reported. Click reactions have found a great variety of applications in organic synthesis (triazole-containing peptides, oligosaccharides, natural products analogues) and also in polymer and material science, supramolecular chemistry, biotechnology and medicinal chemistry.[6,7] The Cu-catalysed Huisgen 1,3-dipolar cycloaddition of terminal alkynes and azides is now the most widely used click reaction. In contrast to the uncatalysed Huisgen reaction,[8] it gives regioselectively the 1,4-regioisomer of 1,2,3-triazoles in high yields; furthermore, the reaction does not require high temperatures and can be performed in a variety of solvents including even water.[6f,9] Click chemistry has been exploited for the generation of neoglycoconjugates such as triazole-based glycopeptides, glycopolymers, glycodendrimers, glycocyclodextrines, glycocalixarenes, as well as glycosylated arrays and glycoclusters. Due to the high yields generally observed, the click reaction is a method of choice for the preparation of carbohydrate multivalent derivatives.[10,11] In carbohydrate chemistry, propargyl glycosides have thus been widely utilized with alkyl azides.[12] Despite all these advantages, click chemistry remains a tool scarcely used in phthalocyanine chemistry.[13]

Depending on the targeting properties and applications, phthalocyanines' properties can be tailored by adjusting the central metal and/or on the substituents' features: position (axial and/or peripheral), number, chemical nature (symmetric or asymmetric pattern). Obtaining self-assembled edifices is of particular interest to promote additional properties and investigate specific properties. Amphiphilic structures, especially from amphiphilic carbohydrate derivatives as described during some of our previous work,[14] are very likely to form self-assembled structures. Aiming at investigating their self-assemblies, we designed two sets of amphiphilic carbohydrate–phthalocyanine conjugates, presented in Fig. 1, with phthalocyanines of an asymmetric AB_3 type substitution pattern. The hydrophobic part is made of six hexylthio chains, and we focused on variations of the hydrophilic part: the nature of the carbohydrate part (glucose, galactose, mannose or lactose) and the type of linkage (glycosidic bond: compounds **1-Sug** or triazole ring: compounds **2-Sug**). Nickel has been chosen as the central metal for its stability. Depending on further studies and targeted applications, different metals will be incorporated at the center of the macrocycle. In addition to self-assembly investigations, such amphiphilic phthalocyanines are likely to be incorporated into artificial membrane systems, such as liposomes. This would be a way to deliver phthalocyanines to cells, especially interesting for Photo Dynamic Therapy treatments. Phthalocyanines are among the most promising

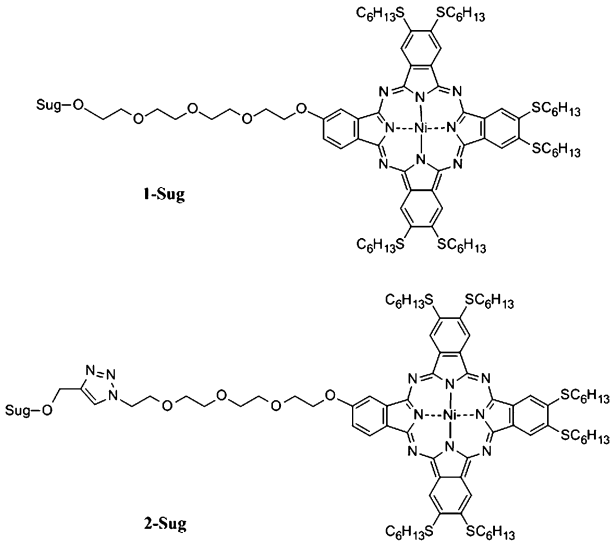


Fig. 1 Structure of glycosylated phthalocyanines **1-Sug** and clicked phthalocyanines **2-Sug** (Sug: β-D-Glc, β-D-Gal, α-D-Man, β-Lac).

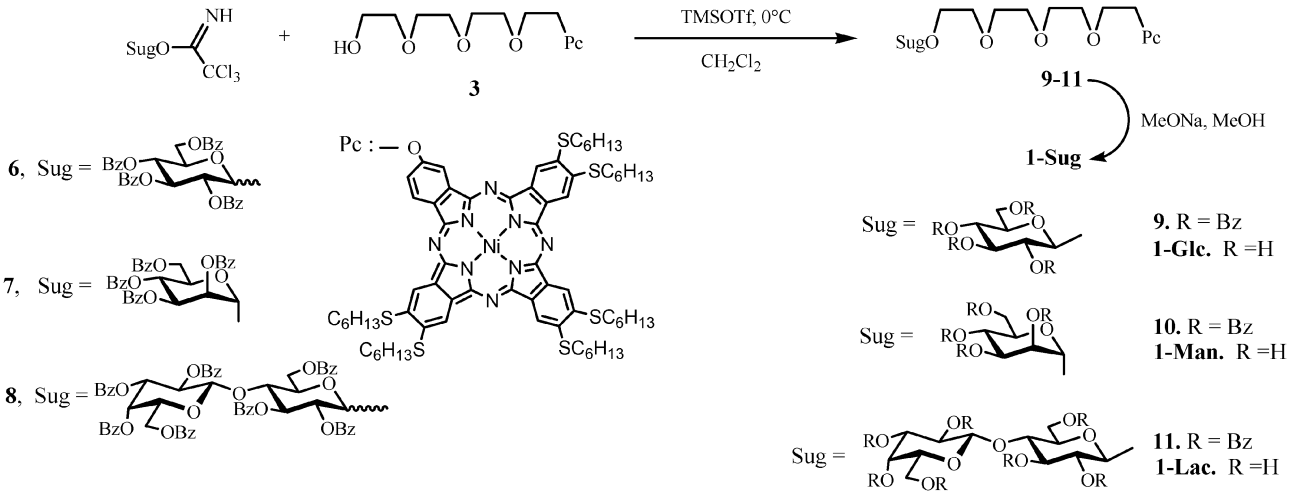
photosensitizers to be used in Photo Dynamic Therapy techniques,[15] and their delivery is of high importance.[15b] Their incorporation in liposomes is a way to optimize their delivery,[15b] and such amphiphilic structures are likely to promote good incorporation into bilayer amphiphilic membranes.

Thus we describe hereafter the synthesis of the two types of amphiphilic phthalocyanine–carbohydrate conjugates: the first set is obtained by glycosylation (compounds **1-Sug**), the second one by click coupling (compounds **2-Sug**), respectively from phthalocyanine–nickel(II) complexes **3** and **5** bearing either a tetraethyleneglycol spacer or an azidotetraethyleneglycol spacer, acting as spacers between the phthalocyanine and the carbohydrate head. Glycosylation reaction for the synthesis of glycosylated phthalocyanines will take advantage to give only one product with a fixed anomeric stereochemistry, due to the presence of C-2 participating groups on the glycosyl donor. The use of the click reaction is another route to glycosylated phthalocyanines which will give the expected products in high yield.

Results and discussion

Synthesis

The hydroxylated phthalocyanine **3** is the common precursor to all the phthalocyanines described hereafter. Its synthesis has been previously described by us.[1j] Compound **3** was used either directly as an acceptor in glycosylation reaction leading after deprotection of the carbohydrate protecting groups to **1-Glc**, **1-Gal**,[1j] **1-Man** and **1-Lac** (Scheme 1), or was converted into the azidophthalocyanine **5** in two steps: mesylation followed by nucleophilic substitution by sodium azide, with an overall yield of nearly 90%. As reported by Chambrier *et al.*[16] the tosylation of a monohydroxylated phthalocyanine remained unsuccessful, when the mesylation could be achieved in good yields, leading to the mesylate **4** as described in a similar case.[17] The subsequent nucleophilic substitution of the mesylate group by sodium azide in DMF was nearly

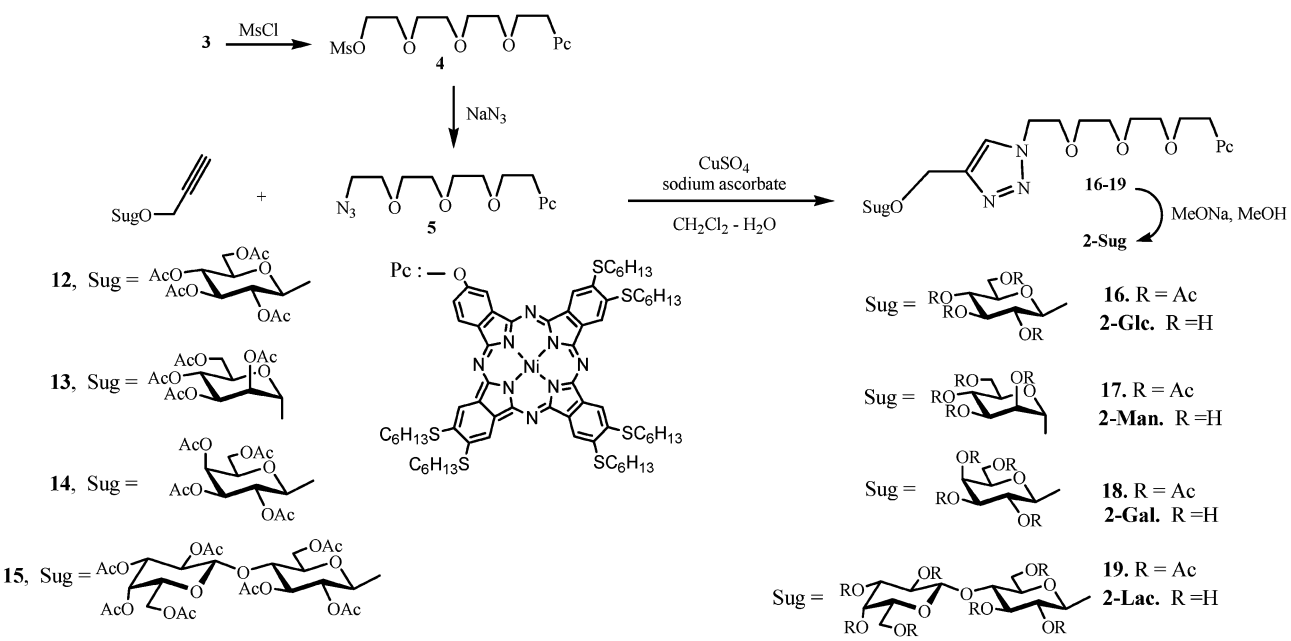


Scheme 1 Synthetic route to phthalocyanines **1-Sug**.

quantitative. The resulting **5** then underwent click coupling with propargyl glycosides, leading after final deprotection of the carbohydrate protecting groups to the clicked amphiphilic phthalocyanines **2-Glc**, **2-Gal**, **2-Man** and **2-Lac** (Scheme 2).

Amongst the various glycosylation methodologies described in the literature for the synthesis of complex carbohydrates,[18] where an activated glycosyl donor reacts with a coupling partner (the glycosyl acceptor) to create a new bound (glycosidic bound) on its anomeric position, the imidate method[19] seemed to be the most efficient one. Thus, our previous experiences in the synthesis of glycolipids[14a,b,20] showed that good yields are often obtained when using imidates as glycosyl donors and also that perbenzoylated imidates are more stable and give generally higher glycosylation yields than peracetylated ones. In addition, it allows working at higher temperatures, avoiding solubilisation problems, which occur in particular with phthalocyanines. Furthermore, the use of ester protecting groups on the C-2 position of the donor will lead to the 1,2-*trans* glycosides, due to the anchimeric assistance during the glycosylation step. Glycosylation reactions were performed in methylene chloride at 0 °C on the acceptor **3** using respectively 2,3,4,6-tetra-*O*-benzoyl-α-D-glucopyranosyl trichloroacetimidate (**6**),[21] 2,3,4,6-tetra-*O*-benzoyl-α-D-mannopyranosyl trichloroacetimidate (**7**)[22] and 4-*O*-(2,3,4,6-tetra-*O*-benzoyl-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-α-D-glucopyranosyl trichloroacetimidate (**8**),[23] leading respectively to glycosylated phthalocyanines **9**, **10** and **11**.

Galactosylation by 2,3,4,6-tetra-*O*-benzoyl-D-galactopyranosyl trichloroacetimidate[20a,24] leading to **1-Gal** after removal of the protecting benzoyl groups was previously described by us.[1j] The donors were prepared in three steps from the free sugars, according to the literature (perbenzoylation with benzoyl chloride in pyridine, cleavage of the anomeric benzoate with hydrazine acetate in *N*,*N*-dimethylformamide, and formation



Scheme 2 Synthetic route to phthalocyanines **2-Sug**.

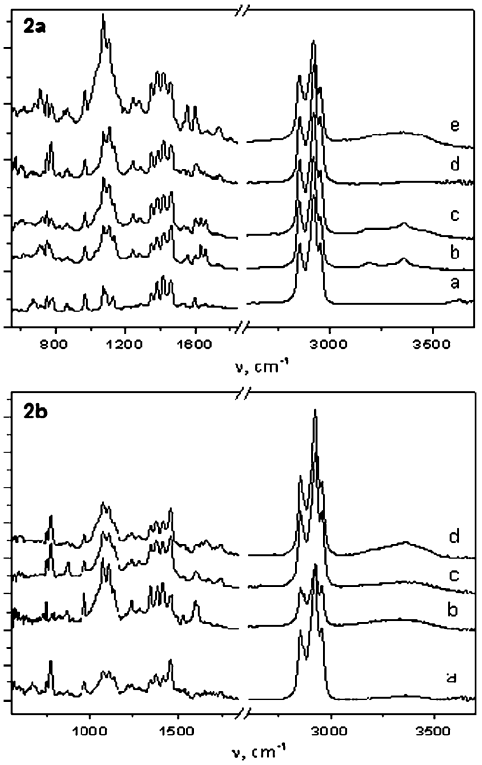


Fig. 2 (**a**) IR spectra of symmetrically substituted $NiPc(SC_6H_{13})_8$ phthalocyanine (a) and glycosylated phthalocyanines **1-Sug**: **1-Man** (b); **1-Glc** (c); **1-Gal** (d); **1-Lac** (e). (**b**) IR spectra of clicked carbohydrate-linked phthalocyanines **2-Sug**: **2-Man** (a); **2-Glc** (b); **2-Gal** (c); **2-Lac** (d).

of the imidate with trichloroacetonitrile in methylene chloride in the presence of DBU). The general procedure for the imidate glycosylation reaction implies its enhancement by a catalytic amount of promoter. In our case, an excess of promoter (trimethylsilyl trifluoromethanesulfonate) was necessary to complete the reaction. This could be explained by the basic character of the phthalocyanine which partially neutralizes the promoter. In the same time, we observed a change of the reaction mixture's colour, from deep green to brownish under acidic conditions. Yields were exceptionally high (90% or more), except in the lactose series (70%) were we encountered some difficulties during the purification step, due to the presence of unanalyzed by-products. The structure of the glycosylated products **9–11** were ascertained from ^1H and ^{13}C NMR data, and also from mass spectrometry measurements. Zemplén de-*O*-benzoylation (catalytic amount of sodium methylate in methanol) afforded the compounds **1-Sug** in quantitative yields. These compounds have been characterized by high-resolution mass spectrometry, UV-vis spectrophotometry and ATR-IR analyses.

Phthalocyanines **2-Sug** have been obtained by clicking propargyl glycosides **12–15** on azidophthalocyanine **5**. In the laboratory, we synthesized the four propargyl glycosides, *i.e.* propargyl 2,3,4,6-tetra-*O*-acetyl-β-D-glucopyranoside (**12**),[25] propargyl 2,3,4,6-tetra-*O*-acetyl-α-D-mannopyranoside (**13**),[26] propargyl 2,3,4,6-tetra-*O*-acetyl-β-D-galactopyranoside (**14**),[25] and propargyl 4-*O*-(2,3,4,6-tetra-*O*-acetyl-β-D-galactopyranosyl)-2,3,6-tri-*O*-acetyl-β-D-glucopyranoside (**15**).[25] When a slight excess of these compounds was reacted with the azidophthalocyanine **5**, under biphasic conditions (methylene chloride–water

Table 1 Vibrational assignments of the absorption modes in IR spectra of **1-Sug** and **2-Sug**.

$NiPc(SC_6H_{13})_8$	1-Man	1-Glc	1-Gal	1-Lac	2-Man	2-Glc	2-Gal	2-Lac	Assignment
671	—	—	—	—	669	—	—	—	Pc breathing
709	707	706	—	710	—	—	—	—	C–H bending
723	721	725	727	—	—	731	—	—	C–H bending + ring deformation
748	750	750	750	748	748	748	749	749	C–H bending
777	764	773	772	776	773	777	774	774	Macrocycle deformation
864	862	864	863	867	864	863	870	864	Isoindole deformations and aza stretching
968	968	968	967	967	968	968	968	968	Benzene wagging
1072	1072	1073	1072	1072	1074	1073	1074	1085	C–H bending
1088	1105	1105	1107	1105	1107	1105	1109	1107	Isoindole breathing + C–H bending
1126	1134	1134	1134	1134	1132	1134	1134	1135	Isoindole deformations + C–H bending
—	1242	1242	1242	1242	1244	1243	1244	1220	C–O–C stretching
1286	1282	1282	1286	1277	1285	1285	1285	1284	Pyrole streching
1348	1348	1348	1348	1348	1348	1349	1350	1348	Pyrole stretching + C–H bending ($-CH_3$, sym.)
1381	1381	1381	1381	1381	1379	1379	1379	1379	C–H bending ($-CH_3$, sym.)
—	—	—	—	—	1388	1389	1387	1387	Triazole stretching
1418	1419	1418	1418	1418	1420	1416	1418	1417	Isoindole stretching
1461	1462	1462	1462	1458	1461	1461	1462	1462	C–H bending ($-CH_3$, asym.) + pyrrole stretching
1533	1535	1535	1534	1553	1537	1533	1533	1536	Pyrrole stretching + aza stretching
1558vw	1556	1556	1560	—	—	—	—	1557	Benzene stretching
1598	1599	1600	1601	1598		1599	1605	1607	Benzene stretching
1637vw	1633	1633	1651	1666	1614	1612	—	—	Benzene stretching
1656vw	1658	1658	1658	1670	—	—	1670	1659	Benzene stretching
—	1734	1728	1739	1734	1739	1734	1739	1743	HO···H
2854	2854	2853	2855	2854	2855	2855	2855	2855	C–H stretching (–CH–, sym.)
2923	2922	2922	2922	2922	2922	2924	2924	2923	C–H stretching (–CH–, asym.)
2955	2954	2954	2954	2954	2955	2956	2956	2955	C–H stretching ($-CH_3$, asym.)
—	3190, 3360	3196, 3358	3362vw	3130–3520	3130–3520	3130–3520	3130–3520	3130–3520	O–H stretching

mixture) as described by Kim *et al.*[27] in presence of sodium ascorbate and copper sulfate pentahydrate, the clicked phthalocyanines **16–19** were obtained in 93–95% yield. These products were fully characterized by ^{1}H, ^{13}C NMR and also HRMS mass spectrometry. As for the benzoylated derivatives **9–11**, the acetylated compounds **16–19** were de-*O*-acetylated by Zemplén method to afford quantitatively the four phthalocyanines **2-Sug**. **2-Sug** compounds have been analyzed using the same techniques as for **1-Sug** derivatives. It must be noted that, compared to their glycosylated analogues, the clicked derivatives are far more polar.

Characterizations

All of the compounds **1-Sug** and **2-Sug** have been characterized by IR-ATR, high-resolution mass spectroscopy and UV-Vis spectroscopy. Their amphiphilic nature lowers their solubility in all of the common solvents, with strong aggregation at the concentrations required for NMR measurements.

Characteristic IR vibrational frequencies of the phthalocyanines are summarized in Table 1. Their assignments were proposed by analogy with the IR characteristics of other substituted phthalocyanines[28] with assistance from the recent theoretical research into the vibrational spectra of monomeric phthalocyanine derivatives.[29] The IR spectra of asymmetric phthalocyanines **1-Sug** and **2-Sug** (Fig. 2) are complex, due to overlaps of the modes belonging to the phthalocyanine ring or to the substituents. Fig. 2a represents the IR spectra of glycosylated phthalocyanines **1-Sug** in the range from 550 to 3700 cm^{-1}. The IR spectrum of symmetrically substituted $NiPc(SC_6H_{13})_8$ phthalocyanine[30] is also given for comparison. The spectra of phthalocyanines **1-Sug** are similar to that of symmetric octasubstituted nickel phthalocyanine, its bending vibrations overlapping the carbohydrates' ones. The differences in the IR spectra of the phthalocyanines bearing different carbohydrate units are especially noticeable here. This spectral range from 1050 to 1200 cm^{-1} is indeed considered as the fingerprint region of sugars.[31] The band at 1242 cm^{-1} is observed due to C–O–C stretching vibrations of the tetraethyleneglycol spacer linking the carbohydrates to the phthalocyanine macrocycle, while this band is absent in the spectrum of $NiPc(SC_6H_{13})_8$. The OH stretching modes for a single glucose molecule are calculated in the range 3660–3600 cm^{-1}.[32] It is well known that the character of experimental spectra is strongly influenced by intermolecular hydrogen bonds. The frequencies associated to the hydroxyl groups are observed at 3190 and 3360 cm^{-1} for **1-Man**, at 3196 and 3358 cm^{-1} for **1-Glc**. For **1-Gal** these bands are revealed at 3198 and 3364 cm^{-1}, with lower intensity. One wide band around 3130–3520 cm^{-1}, which is also strongly affected by the presence of the hydrogen bonds in the crystal structure, is observed in the IR spectrum of **1-Lac**. Appearance of this very broad band is probably due to the increased opportunities to form hydrogen bonding for a disaccharide derivative which has more hydroxyl groups than other derivatives. Fig. 2b represents the IR spectra of the clicked carbohydrate-linked phthalocyanines (**2-Sug**). Their spectra are very similar to those observed for the **1-Sug** phthalocyanines. A new shoulder at 1387–1389 cm^{-1} corresponding to triazole stretching appears in the spectra of **2-Sug**. The changes in ratio of intensities in the range 1330–1480 cm^{-1} appear to be due to coupling with stretching vibrations of the triazole fragment. Wide bands around 3130–3520 cm^{-1} are associated to the hydroxyl groups for all **2-Sug** derivatives. The presence of these broad bands is attributed to the possibility to form additional intermolecular hydrogen bond contacts between saccharidic and triazole fragments.

The compounds **1-Sug** and **2-Sug** have been characterized by ESI or MALDI mass spectrometry. Fig. 3a and b show, for example, the Maldi-TOF mass spectrum of compound **9**, with characteristic mono and dimeric monocharged species which also could likely preexist in solution. Fig. 3c shows the experimental and simulated isotopic pattern for the dicharged monomeric species in ESI high resolution mass spectrometry.

Each of these phthalocyanines is slightly soluble in chloroform, thus this is the solvent selected for UV-Vis experiments. B- and Q-band values with corresponding molar extinction

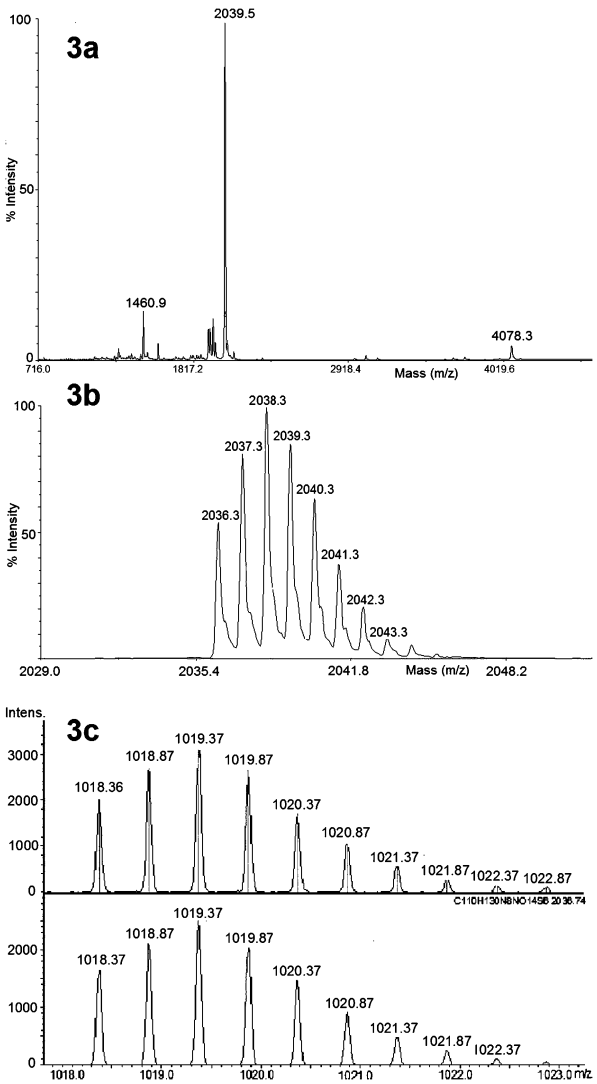


Fig. 3 (a) ESI-MS spectrum of compound **9**; (b) close-up of the M^+ isotopic distribution for compound **9**; (c) close-up of the M^{2+} isotopic distribution for compound **9** (ESI-MS). Top: experimental spectrum, bottom: simulation.

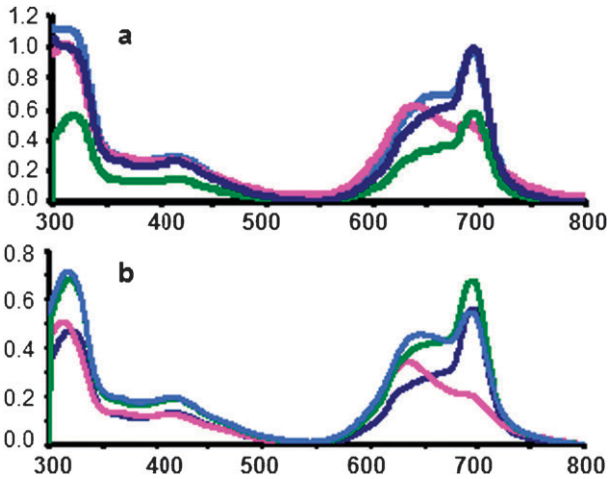


Fig. 4 (a) UV-vis spectra of **1-Glc**, **1-Man**, **1-Gal** and **1-Lac** in chloroform, at 10 μM; (b) UV-vis spectra of **2-Glc**, **2-Man**, **2-Gal** and **2-Lac** in chloroform, at 10 μM. Glc: green, Man: light blue, Gal: dark blue, Lac: pink.

Table 2 Maximum absorption wavelengths λ_{max} and logarithmic values of extinction coefficients ε

Compound	λ_{max}, nm (log ε)
1-Glc	320 (4.75), 695 (4.76)
1-Gal[10]	319 (4.99), 695 (4.99)
1-Man	317 (4.99), 694 (4.99)
1-Lac	313 (5.01), 639 (4.80), 690 (4.70)
2-Glc	320 (4.83), 695 (4.83)
2-Gal	320 (4.67), 695 (4.75)
2-Man	320 (4.85), 694 (4.74)
2-Lac	315 (4.69), 636 (4.53), 690 (4.32)

coefficients for both series are given in Table 2. UV-Vis spectra of the **1-Sug** series (Fig. 4a) show that the nature of the carbohydrate has no influence on the maximum absorption wavelengths. Compared to **1-Glc**, **1-Man** and **1-Gal** whose Q-band is quite sharp, with a maximum of absorption at 695 nm, classic for substituted Ni(II)Pc, **1-Lac** is a bit more aggregated, as shown by the enlarged shape of its Q-band (Fig. 4a). This is probably due to the increased opportunities to form hydrogen bonding for a disaccharide derivative, fostering the formation of dimeric structures. The presence of the triazole ring (compounds **2-Sug**) doesn't fundamentally modify the electronic absorption properties compared to those of the analogous **1-Sug** compounds: the relative shapes of the Q-band are the same for phthalocyanine bearing the same carbohydrate. It means that the triazole ring has no significant influence on the excitation of the phthalocyanine ring upon irradiation by a photon.

Conclusions

Two sets of amphiphilic carbohydrate–phthalocyanine conjugates have been synthesized and characterized, bearing glucose, galactose, mannose or lactose heads facing six hexylthio chains. The carbohydrates have been grafted on a preformed phthalocyanine, by direct glycosylation of a hydroxylated one, or by using click chemistry, of propargylic glycosides on a novel azido-phthalocyanine. These compounds are likely to exhibit self-assembling properties that we are currently investigating.

Experimental

General information

Dichloromethane used for glycosylation reactions was washed twice with water, dried with $CaCl_2$ and distilled from CaH_2. Methanol was distilled from magnesium. CH_2Cl_2 was stored over 4 Å molecular sieves; and MeOH over 3 Å molecular sieves. Thin layer chromatography was performed on aluminium sheets coated with Silica gel 60 F_{254} (E. Merck). Compounds were visualized by spraying the TLC plates with dilute 15% aq H_2SO_4, followed by charring at 150 °C for a few min. Column chromatography was performed on Silica-gel Geduran Si 60 (Merck). ^1H and ^{13}C NMR spectra were recorded with Bruker DRX300 spectrometers working at 300 MHz and 75 MHz respectively with Me_4Si as internal standard, or on a Varian 500 MHz spectrometer. For ATR-IR spectra acquisition the ATR accessory (PIKE Technologies) was accommodated in the sample compartment of a Vertex 80 FTIR spectrometer (internal reflection element: ZnSe crystal mounted onto a stainless steel plate, resolution: 4 cm^{-1}. The phthalocyanine solution in chloroform was applied directly onto the upper face of a horizontal sampling ATR accessory. The spectrum was recorded after chloroform evaporation). Optical absorption spectra in the UV-visible region were recorded with a Schimadzu 2001 UV spectrophotometer. ESI low or high resolution mass spectra were recorded on a MicroTOF-Q Bruker Daltonics instrument, detecting positive ions. Samples in dichloromethane were infused directly into the source (5 μL min^{-1}) using a syringe pump. The following source parameters were applied: spray voltage 3.0–3.5 kV, heated capillary at 200 °C. MALDI mass spectra were recorded on a Voyager DE-PRO Applied Biosystems instrument. Alternatively, ESI spectra were recorded with a LCQ Advantage ion trap mass spectrometer and ESI high resolution measurements were obtained with a MAT 95XL (ThermoFinnigan) electromagnetic mass spectrometer.

Syntheses

[2,3,9,10,16,17-Hexa-(1-hexylthio)-23-(12-*O*-mesyl-(1,4,7,10-tetraoxadodecyl)] phthalocyaninato nickel (4). Hydroxylated phthalocyanine **3** (380 mg, 0.26 mmol) in pyridine (15 mL) was cooled by an ice bath. Methanesulfonyl chloride (2 equiv., 40 μL) was added and the reaction stirred overnight at room temperature, then poured in water and filtered. The green solid residue was dissolved in dichloromethane, washed with a dilute solution of HCl. The organic phase was dried (Na_2SO_4) and concentrated to afford the crude product which was purified by column chromatography, by elution with CH_2Cl_2–EtOH (25 : 1), yielding 372 mg of **4** (93%). Green solid. ^1H NMR ($CDCl_3$): δ 8.04–7.74 (m, 9H, aromatics), 3.25–4.32 (m, 28H, $6SCH_2$, $(OCH_2)_4$), 3.01 (s, 3H, SO_2CH_3), 1.96 (m, 12H, $6SCH_2CH_2$), 1.18 (bs, 36H, $(CH_2)_3CH_3$), 0.96 (m, 18H, CH_3). ^{13}C NMR ($CDCl_3$): δ 137.93, 133.81, 128.78, 127.77, 127.38, 125.04 (aromatics), 70.03, 69.75, 69.74, 69.70,

69.22, 68.22, 68.10 (OCH_2), 36.75 (SO_2CH_3), 21.74, 28.23, 30.83, 30.84, 30.87 (CH_2 alkyl chains), 14.23 (CH_3 alkyl chains). Elemental analysis Calc. for $C_{77}H_{106}N_8NiO_7S_7$: C, 60.10; H, 6.94; N, 7.28; Found: C, 60.07; H, 6.94; N, 7.25.

[2,3,9,10,16,17-Hexa-(1-hexylthio)-23-(12-azido-(1,4,7,10-tetraoxadodecyl)] phthalocyaninato nickel (5). Mesylated phthalocyanine **4** (290 mg, 0.19 mmol) and sodium azide (50 mg, 0.77 mmol, 4 equiv.) were stirred overnight in DMF (5 mL) at 80 °C. The reaction mixture was then poured in water, and the green precipitate washed thoroughly by water, then acetone and dried, yielding 267 mg of **5** (95%). Green solid. ^{1}H NMR ($CDCl_3$): δ 8.22–7.81 (m, 9H, aromatics), 3.41–4.23 (m, 28H, $6SCH_2$, $(OCH_2)_4$), 2.01 (m, 12H, $6SCH_2CH_2$), 1.23 (bs, 36H, $(CH_2)_3CH_3$), 0.91 (m, 18H, CH_3). ^{13}C NMR ($CDCl_3$): δ 139.22, 134.02, 126.91, 124.02, 123.81 (aromatics), 71.11, 70.75, 69.24, 69.42, 68.25, 68.86, 68.02 (OCH_2), 62.35 (C–N_3), 23.77, 27.73, 29.44, 31.83, 31.14, 30.88 (CH_2 alkyl chains), 14.45 (CH_3 alkyl chains). Elemental analysis Calc. for $C_{76}H_{103}N_{11}NiO_4S_6$: C, 61.44; H, 6.99; N, 10.37; Found: C, 61.49; H, 7.04; N, 10.38.

General method for the glycosylation reaction (Method 1). The phthalocyanine **3** (75 μmol) and the perbenzoylated-D-glycopyranosyl trichloroacetimidate **6–8** (1.2 to 2 equiv.) were dissolved in dry CH_2Cl_2 (5.0 ml) in the presence of crushed activated 4 Å molecular sieves (250 mg) and the suspension was cooled to 0 °C with stirring under an argon atmosphere. Trimethylsilyl trifluoromethanesulfonate (25 μL, 130 μmol) was added and the mixture was stirred overnight at 0 °C. After filtration on celite, and addition of CH_2Cl_2 (20 ml), the organic phase was washed with satd aq $NaHCO_3$ (5 mL), dried (Na_2SO_4) and concentrated to afford the crude product which was purified by column chromatography, by elution first with EtOAc–petroleum ether (1 : 1), then with CH_2Cl_2–EtOH (25 : 1).

General method for the click reaction (Method 2). To a mixture of the azido phthalocyanine **5** (52–88 mg, 35–60 μmol) and propargyl glycoside **12–15** (16–25 mg, 41–64.0 μmol) in CH_2Cl_2 (0.5–0.75 mL) were successively added water (0.5–0.75 mL), sodium ascorbate (2.0–3.0 mg, 8.6–12.9 μmol) and copper sulfate pentahydrate (1.7–2.6 mg, 6.8–10.2 μmol). The mixture was stirred vigorously for 16 h, diluted with CH_2Cl_2 (10–15 mL) and washed with water (5 mL). The organic phase was dried, concentrated and the residue was purified by column chromatography using 100 : 5 CH_2Cl_2–EtOH as eluent.

General procedure for de-*O*-acylation reaction (Method 3). The perbenzoylated phthalocyanines **9–11** were dissolved in a 1 : 1 CH_2Cl_2–MeOH mixture (10 mL) containing a catalytic amount of MeONa and stirring was maintained overnight. After concentration, the product was washed three times with petroleum ether and dissolved again in CH_2Cl_2 (25 mL). The organic phase was washed with water (2 × 5 mL), dried (Na_2SO_4) and concentrated again. Products **1-Sug** were recovered in quantitative yields and were chromatographically pure. For the peracetylated phthalocyanines **16–19**, the same experimental procedure was followed, without the washings with petroleum ether, affording the pure derivatives **2-Sug**.

[2,3,9,10,16,17-Hexa-(1-hexylthio)-23-(12-(1,4,7,10-tetraoxadodecyl) 2,3,4,6-tetra-*O*-benzoyl-β-D-glucopyranoside)]-phthalocyaninato nickel (9). Obtained in 90% yield, following method 1, from phthalocyanine **3** (109 mg, 75 μmol) and 2,3,4,6-tetra-*O*-benzoyl-D-glucopyranosyl trichloroacetimidate (**6**) (66.4 mg, 90 μmol, 1.2 equiv.). 138 mg; green oily derivative; R_f 0.40 (25 : 1 CH_2Cl_2–EtOH). ^{1}H NMR ($CDCl_3$): δ 8.20–7.28 (m, aromatic H), 5.91 (dd, 1H, $J_{2,3}$ 9.7, $J_{3,4}$ 9.6 Hz, H-3), 5.70 (dd, 1H, $J_{4,5}$ 9.6 Hz, H-4), 5.56 (dd, 1H, $J_{1,2}$ 7.9 Hz, H-2), 4.65 (dd, 1H, $J_{5,6a}$ 3.1, $J_{6a,6b}$ 12.2 Hz, H-6a), 4.58 (m, 2H, $CH_2OC_6H_3$), 4.50 (dd, 1H, $J_{5,6b}$ 5.0 Hz, H-6b), 4.23 (m, 2H, OCH_2), 4.16 (ddd, 1H, H-5), 4.06 (ddd, 1H, C-1OC*H*), 3.95 (t, 1H, OCH_2), 3.85 (ddd, 1H, C-1OC*H*), 3.80–3.56 (m, 8H, $4OCH_2$), 3.37–3.10 (m, 12H, $6SCH_2$), 2.10–1.95 (m, 12 H, $6SCH_2CH_2$), 1.85–1.68 (m, 12 H, $6SCH_2CH_2CH_2$), 1.60–1.45 (m, 24 H, $12CH_2$ alkyl chains), 1.10–0.97 (m, 18H, $6CH_3$ alkyl chains). ^{13}C NMR ($CDCl_3$): δ 166.19, 165.89, 165.28, 165.15 (C_6H_5), 133.52, 33.35, 133.32, 133.21, 129.92–128.39 (C_6H_5), 101.50 (C-1), 73.00 (C-3), 72.31 (C-5), 71.99 (C-2), 71.01, 70.73, 70.73, 70.44, 70.24 (OCH_2 ethyleneglycol), 69.86 (C-4), 69.54 (CH_2OC-1), 68.02 ($CH_2OC_6H_3$), 63.25 (C-6), 34.16, 33.96, 33.80, 33.4131.98, 29.35, 28.75, 22.93 (CH_2 alkyl chains), 14.39 (CH_3 alkyl chains). HRMS (ESI^+) calc. for $C_{110}H_{130}N_8NiO_{14}S_8$, 2036.7379; found 2036.7318; M^{2+} calc. 1018.3687; found 1018.3685.

[2,3,9,10,16,17-Hexa-(1-hexylthio)-23-(12-(1,4,7,10-tetraoxadodecyl) 2,3,4,6-tetra-*O*-benzoyl-α-D-mannopyranoside)]-phthalocyaninato nickel (10). Obtained in 90% yield, following method 1, from phthalocyanine **3** (108 mg, 74 μmol) and 2,3,4,6-tetra-*O*-benzoyl-α-D-mannopyranosyl trichloroacetimidate (**7**) (102 mg, 138 μmol; 2 equiv.). 135 mg; green oily derivative; R_f 0.40 (25 : 1 CH_2Cl_2–EtOH). ^{1}H NMR ($CDCl_3$): δ8.08–7.23 (m, Aromatic H), 6.14 (dd, 1H, $J_{3,4}$ 10.0, $J_{4,5}$ 9.6 Hz, H-4), 5.97 (dd, 1H, $J_{2,3}$ 3.2 Hz, H-3), 5.76 (dd, 1H, $J_{1,2}$ 1.5 Hz, H-2), 5.19 (d, 1H, H-1), 4.71 (bd, 1H, $J_{5,6a} < 1.0$ Hz, $J_{6a,6a}$ 11.0 Hz, H-6a), 4.60 (m, 2H, $CH_2OC_6H_3$), 4.54 (ddd, 1H, $J_{5,6b}$ 3.9 Hz, H-5), 4.45 (dd, 1H, H-6b), 4.24 (m, 2H, OCH_2), 4.06–3.84 (m, 12H, $6OCH_2$), 3.40–3.10 (m, 12H, $6SCH_2$), 2.12–1.92 (m, 12H, $6SCH_2CH_2$), 1.85–1.67 (m, 12H, $6SCH_2CH_2CH_2$), 1.60–1.40 (m, 24H, $12CH_2$ alkyl chains), 1.10–0.97 (m, 18H, $6CH_3$ alkyl chains). ^{13}C NMR ($CDCl_3$): δ 166.23, 165.59, 165.56, 165.45 (COC_6H_5), 133.52, 133.25, 133.10, 129.99–128.40 (C_6H_5), 97.95 (C-1), 71.14, 70.97, 70.92, 70.33, 70.27 (OCH_2), 70.59 (C-2), 70.20 (C-3), 68.95 (C-5), 68.03 ($CH_2OC_6H_3$), 67.77 (CH_2OC-1), 67.05 (C-4), 62.90 (C-6), 34.17, 33.99, 33.81, 33.40, 32.00, 29.73–28.79, 22.95, 22.92, 22.89 (CH_2 alkyl chains), 14.39 (CH_3 alkyl chains). HRMS (ESI^+) calc. for $C_{110}H_{130}N_8NiO_{14}S_6$, 2036.7379; found, 2036.7325.

[2,3,9,10,16,17-Hexa-(1-hexylthio)-23-(12-(1,4,7,10-tetraoxadodecyl) 4-*O*-(2,3,4,6-tetra-*O*-benzoyl-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranoside)]phthalocyaninato nickel (11). Obtained in 70% yield, following method 1, from phthalocyanine **3** (105 mg, 72 μmol) and 4-*O*-(2,3,4,6-tetra-*O*-benzoyl-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-α-D-glucopyranosyl trichloroacetimidate (**8**) (131 mg, 108 μmol;

1.5 equiv.). Green oily derivative; R_f 0.50 (25 : 1 CH_2Cl_2–EtOH). ^{1}H NMR ($CDCl_3$): δ 8.10–7.10 (m, 35H, 7 C_6H_5), 5.85 (dd, 1H, $J_{2,3}$ 9.8, $J_{3,4}$ 9.1 Hz, H-3), 5.72 (m, 2H, H-2′, H-4′), 5.48 (dd, 1H, $J_{1,2}$ 7.9 Hz, H-2), 5.37 (dd, 1H, $J_{2',3'}$ 10.3, $J_{3',4'}$ 3.0 Hz, H-3′), 4.88 (d, 1H, H-1), 4.82 (d, 1H, $J_{1',2'}$ 7.9 Hz, H-1′), 4.65–4.50 (m, 3H, H-6a, CH_2OC$_6$H$_3$), 4.49 (dd, 1H, $J_{5,6b}$ 3.8, $J_{6a,6b}$ 11.8 Hz, H-6b), 4.25 (dd, 1H, $J_{4,5}$ 10.0 Hz, H-4), 4.22–4.15 (m, 2H, C-1OCH_2), 3.98–3.45 (m, 16H, 6OCH_2, H-5, H-5′, H-6′a, H-6′b), 3.40–3.05 (m, 12H, 6SCH_2), 2.12–1.92 (m, 12H, 6SCH$_2$CH_2), 1.85–1.67 (m, 12H, 6SCH$_2$CH$_2$CH_2), 1.60–1.40 (m, 24H, 12CH$_2$ alkyl chains), 1.10–0.97 (m, 18H, 6CH_3 alkyl chains). ^{13}C NMR ($CDCl_3$): δ 165.91, 165.63, 165.48, 165.31, 165.29, 165.24 (*C*OC$_6$H$_5$), 133.62, 133.47, 128.71–128.32 (C_6H_5), 101.40 (C-1), 101.10 (C-1′), 76.13 (C-4), 73.12 (C-3), 72.99 (C-5), 71.86 (C^{-2}, C-3′), 71.47 (C-5′), 69.98 (C-2′), 67.60 (C-4′), 70.97, 70.78, 70.66, 70.33, 70.20, 69.55 (O*C*H$_2$), 67.96 (*C*H$_2$OC$_6$H$_3$), 62.49 (C-6), 61.13 (C-6′), 33.91, 31.96, 29.90, 29.33, 28.88, 22.36 (*C*H$_2$ alkyl chains), 14.37 (*C*H$_3$ alkyl chains). MS (Maldi) calc. for $C_{132}H_{152}N_8Ni_1O_{22}S_6$, 2510.87; found 2510.90.

[2,3,9,10,16,17-Hexa-(1-hexylthio)-23-((1-(1,4,7,10-tetraoxadodecyl)-1*H*-1,2,3-triazol-4-yl)methyl 2,3,4,6-tetra-*O*-acetyl-β-D-glucopyranoside)]phthalocyaninato nickel (16). Obtained in 95% yield, following method 2, from propargyl 2,3,4,6-tetra-*O*-acetyl-β-D-glucopyranoside (**12**) (27.6 mg, 72 μmol) and phthalocyanine **5** (88 mg, 60 μmol). 105 mg; green oily derivative; R_f 0.34 (20 : 1 CH_2Cl_2–EtOH). ^{1}H NMR ($CDCl_3$): δ 7.76 (s, 1H, =C*H*), 5.19 (dd, 1H, $J_{2,3}$ 9.6, $J_{3,4}$ 9.1 Hz, H-3), 5.09 (dd, 1H, $J_{4,5}$ 9.9 Hz, H-4), 5.01 (dd, 1H, $J_{1,2}$ 7.9 Hz H-2), 4.95 and 4.83 (2d, 2H, *J* 12.5 Hz, OCH_2C=), 4.70 (d, 1H, H-1), 4.61–4.55 (m, 2H, CH_2N), 4.27 (dd, 1H, $J_{5,6a}$ 4.6, $J_{6a,6b}$ 12.3 Hz, H-6a), 4.26–4.20 (m, 2H, C$_6$H$_3$OCH_2), 4.14 (d, 1H, $J_{5,6b}$ 1.8 Hz, H-6b), 4.00–3.65 (m, 13H, H-5, 6OCH_2), 3.60–3.00 (m, 12H, 6SCH$_2$), 2.09, 2.01, 1.99, 1.99 (4s, 12H, 4CH_3COO), 2.10–1.95 (m, 12H, 6SCH$_2$CH_2), 1.85–1.72 (m, 12H, 6SCH$_2$CH$_2$CH_2), 1.60–1.45 (m, 24H, 12CH_2 alkyl chains), 1.10–0.97 (m, 18H, 6CH_3 alkyl chains). ^{13}C NMR ($CDCl_3$): δ 170.73, 170.25, 169.51, 169.43 (*C*OCH$_3$), 124.09 (=*C*H), 99.84 (C-1), 72.87 (C-3), 71.97 (C-5), 71.29 (C-2), 71.09, 70.83, 70.76, 70.71, 70.28, 69.59 (*C*H$_2$O), 68.39 (C-4), 62.90 (*C*H$_2$C=), 61.91 (C-6), 50.40 (*C*H$_2$N), 33.91, 31.98, 29.43, 29.33, 29.01, 28.90, 28.76, 22.89, 22.85 (*C*H$_2$ alkyl chains), 20.84, 20.72, 20.68, 20.68 (*C*H$_3$COO), 14.36 (*C*H$_3$ alkyl chains). HRMS (ESI) calc. for $C_{93}H_{125}N_{11}NiO_{14}S_6$,1869.7085; found 1869.7014.

[2,3,9,10,16,17-Hexa-(1-hexylthio)-23-((1-(1,4,7,10-tetraoxadodecyl)-1*H*-1,3-triazol-4-yl)methyl 2,3,4,6-tetra-*O*-acetyl-α-D-mannopyranoside)] phthalocyaninato nickel (17). Obtained in 94% yield, following method 2, from propargyl 2,3,4,6-tetra-*O*-acetyl-α-D-mannopyranoside (**13**) (25 mg, 65 μmol) and phthalocyanine **5** (80 mg, 54 μmol). 97 mg; green oily derivative; R_f 0.34 (20 : 1 CH_2Cl_2–EtOH). ^{1}H NMR ($CDCl_3$): δ 7.79 (s, 1H, =C*H*), 5.33 (dd, 1 H, $J_{2,3}$ 3.5 Hz, $J_{3,4}$ 9.8 Hz, H-3), 5.31–5.29 (m, 1 H, H-4), 5.26 (dd, 1H, $J_{1,2}$ 1.9, H-2), 4.98 (d, 1H, H-1), 4.85 and 4.69 (2d, 2 H, *J* 12.2 Hz, OCH_2C=), 4.61–4.57 (m, 2H, CH_2N), 4.31 (dd, 1H, $J_{5,6a}$ 5.2, $J_{6a,6b}$ 12.6 Hz, H-6a), 4.28–4.22 (m, 2H, C$_6$H$_3$OCH_2), 4.14–4.07 (m, 2H, H-5, H-6b), 4.00–3.70 (m, 12H, 6OCH_2), 3.60–3.10 (m, 12H, 6SCH_2), 2.14, 2.11, 2.03, 1.98 (4s, 12H, 4CH_3COO), 2.10–1.95 (m, 12H, 6SCH$_2$CH_2), 1.85–1.72 (m, 12H, 6 SCH$_2$CH$_2$CH_2), 1.60–1.45 (m, 24 H, 12CH_2 alkyl chains), 1.10–0.97 (m, 18H, 6CH_3 alkyl chains). ^{13}C NMR ($CDCl_3$): δ 170.75, 170.08, 169.93, 169.77 (*C*=O), 124.23 (NCH=C), 96.89 (C-1), 71.09, 70.79, 70.72, 70.29, 69.57 (O*C*H$_2$), 69.54 (C-2), 69.14 (C-3), 68.76 (C-5), 66.14 (C-4), 62.43 (C-6), 61.01 (*C*H$_2$OC=), 33.89, 31.98, 29.32, 29.28, 22.89, 22.85 (*C*H$_2$ alkyl chains), 20.95, 20.86, 20.77, 20.75 (*C*H$_3$COO), 14.36 (*C*H$_3$ alkyl chains). HRMS (ESI) calc. for $C_{93}H_{125}N_{11}NiO_{14}S_6$,1869.7085; found 1869.7066.

[2,3,9,10,16,17-Hexa-(1-hexylthio)-23-((1-(1,4,7,10-tetraoxadodecyl)-1*H*-1,2,3-triazol-4-yl)methyl 2,3,4,6-tetra-*O*-acetyl-β-D-galactopyranoside)] phthalocyaninato nickel (18). Obtained in 95% yield, following method 2, from propargyl 2,3,4,6-tetra-*O*-acetyl-β-D-galactopyranoside (**14**) (16 mg, 41 μmol) and phthalocyanine **5** (52 mg, 35 μmol). 62 mg; green oily derivative; R_f 0.34 (20 : 1 CH_2Cl_2–EtOH). HRMS (ESI) calc. for $C_{93}H_{125}N_{11}NiO_{14}S_6$,1869.7085; found, 1869.7067. ^{1}H NMR ($CDCl_3$): δ 7.73 (s, 1H, =C*H*), 5.39 (dd, 1H, $J_{3,4}$ 3.4, $J_{4,5}$ 0.5 Hz, H-4), 5.28 (dd, 1H, $J_{1,2}$ 7.9, $J_{2,3}$ 10.4 Hz, H-2), 5.01 (dd, 1H, H-3), 4.97 and 4.82 (2d, 2H, *J* 12.5 Hz, OCH_2C=), 4.67 (d, 1H, H-1), 4.63–4.53 (m, 2H, CH_2N), 4.30–4.20 (m, 2H, C$_6$H$_3$OCH_2), 4.16 (d, 2H, $J_{5,6a}$ 6.4, $J_{5,6b}$ 6.4 Hz, H-6a, H-6b), 4.00–3.65 (m, 13H, H-5, 6OCH_2), 3.50–3.05 (m, 12H, 6SCH_2) 2.15, 2.05, 1.99, 1.97 (4s, 12H, 4CH_3COO), 2.10–1.95 (m, 12H, 6SCH$_2$CH_2), 1.85–1.68 (m, 12H, 6SCH$_2$CH$_2$CH_2), 1.60–1.45 (m, 24H, 12CH_2 alkyl chains), 1.10–0.97 (m, 18H, 6CH_3 alkyl chains). ^{13}C NMR ($CDCl_3$): δ 170.53, 170.33, 170.176, 169.51 (CH$_3$*C*OO), 144.09 (*C* = quat), 124.09 (NCH=C), 100.53 (C-1), 70.97 (C-3), 70.92 (C-5), 71.13, 70.88, 70.81, 70.77, 69.62 (O*C*H$_2$), 68.89 (C-2), 67.17 (C-4), 62.91 (*C*H$_2$C=), 61.35 (C-6), 50.50 (*C*H$_2$N), 33.96, 32.02, 31.98, 29.82, 29.46, 29.37, 29.04, 28.95, 22.94, 22.89 (*C*H$_2$ alkyl chains), 20.87, 20.82, 20.79, 20.69 (*C*H$_3$CO), 14.56 (*C*H$_3$ alkyl chains).

[2,3,9,10,16,17-Hexa-(1-hexylthio)-23-((1-(1,4,7,10-tetraoxadodecyl)-1*H*-1,2,3-triazol-4-yl)methyl 4-*O*-(2,3,4,6-tetra-*O*-acetyl-β-D-galactopyranosyl)-2,3,6-tri-*O*-acetyl-β-D-glucopyranoside]phthalocyaninato nickel (19). Obtained in 93% yield, following method 2, from propargyl 4-*O*-(2,3,4,6-tetra-*O*-acetyl-β-D-galactopyranosyl)-2,3,6-tri-*O*-acetyl-β-D-glucopyranoside (**15**) (28.3 mg, 72 μmol) and phthalocyanine **5** (50 mg, 35 μmol). 68 mg; green oily derivative; R_f 0.34 (20 : 1 CH_2Cl_2–EtOH). HRMS (ESI) calc. for $C_{105}H_{141}N_{11}NiO_{22}S_6$, 2157.7930; found 2157.7904. ^{1}H NMR: ($CDCl_3$): δ 5.34 (dd, 1H, $J_{3',4'}$ 3.4, $J_{4',5'}$ 0.5 Hz, H-4′), 5.22 (dd, 1H, $J_{2,3}$ 9.3, $J_{3,4}$ 9.2 Hz, H-3), 5.11 (dd, 1H, $J_{1',2'}$ 7.9, $J_{2',3'}$ 10.4 Hz, H-2′), 4.95 (dd, 1H, H-3′), 4.93–4.88 (m, 2H, H-2, 0.5CH_2C=), 4.80 (d, 1H, *J* 12.6 Hz, 0.5CH_2C=), 4.65 (d, 1H, $J_{1,2}$ 7.9 Hz, H-1), 4.60–4.54 (m, 2H, CH_2N), 4.51 (dd, 1H, $J_{5,6a}$ 1.5, $J_{6a,6b}$ 11.9 Hz, H-6a), 4.48 (d, 1H, H-1′), 4.28–4.20 (m, 2 H, C$_6$H$_3$OCH_2), 4.17–4.08 (m, 3H, H-6b, H-6′a, H-6′b), 4.00–3.70 (m, 14H, H-4, H-5′, 6OCH_2), 3.65 (ddd, 1H, $J_{4,5}$ 9.9, $J_{5,6b}$ 4.5 Hz, H-5), 3.60–3.00 (m, 12 H, 6SCH$_2$CH_2), 2.15, 2.13, 2.05, 2.05, 2.03, 2.00, 1.96 (7s, 21H, 4CH_3COO), 2.10–1.95 (m, 12H, 6SCH$_2$CH_2),

1.85–1.68 (m, 12H, $6SCH_2CH_2CH_2$), 1.60–1.45 (m, 24H, $12CH_2$ alkyl chains), 1.10–0.97 (m, 18H, $6CH_3$ alkyl chains). ^{13}C NMR ($CDCl_3$): δ 170.45, 170.24, 170.15, 169.80, 169.74, 169.65 ($COCH_3$), 124.05 (CH=), 101.12 (C-1′), 99.57 (C-1), 76.24 (C-4), 72.85 (C^{-3}, C-5), 71.65 (C-2), 71.06 (C-3′), 70.73 (C-5′), 69.16 (C-2′), 66.69 (C-4′), 71.10, 70.84, 70.78, 70.71, 70.31, 69.61 (OCH_2), 62.86 (OCH_2C=), 61.97 (C-6), 60.81 (C-6′), 50.40 (CH_2N), 33.91, 31.96, 29.44, 29.34, 28.94, 22.91, 22.85 (CH_2 alkyl chains), 14.36 (CH_3 alkyl chains).

[2,3,9,10,16,17-Hexa-(1-hexylthio)-23-(12-(1,4,7,10-tetraoxadodecyl) β-D-glucopyranoside)]phthalocyaninato nickel (1-Glc). Obtained from **9** following method 3. Green oily derivative. R_f 0.52 (65 : 25 : 4 $CHCl_3$–MeOH–H_2O). HRMS (ESI) calc. for $C_{82}H_{114}N_8NiO_{10}S_6$, 1620.6335; found 1620.6378.

[2,3,9,10,16,17-Hexa-(1-hexylthio)-23-(12-(1,4,7,10-tetraoxadodecyl) α-D-mannopyranoside)]phthalocyaninato nickel (1-Man). Obtained from **10** following method 3. Green oily derivative. R_f 0.52 (65 : 25 : 4 $CHCl_3$–MeOH–H_2O).HRMS (ESI) calc. for $C_{82}H_{114}N_8NiO_{10}S_6$, 1620.6335; found 1620.6318.

[2,3,9,10,16,17-Hexa-(1-hexylthio)-23-(12-(1,4,7,10-tetraoxadodecyl) 4-*O*-β-D-galactopyranosyl-2,3,6-tri-*O*-benzoyl)-β-D-glucopyranoside)]phthalocyaninato nickel (1-Lac). Obtained from **11** following method 3. Green oily derivative. R_f 0.38 (65 : 25 : 4 $CHCl_3$–MeOH–H_2O). HRMS (ESI) calc. for $C_{88}H_{124}N_8NiO_{15}S_6$, 1782.6864; found 1782.6884.

[2,3,9,10,16,17-Hexa-(1-hexylthio)-23-((1-(1,4,7,10-tetraoxadodecyl)-1*H*-1,3-triazol-4-yl)methyl β-D-glucopyranoside)]-phthalocyaninato nickel (2-Glc). Obtained following method 3 from **16**. Green oily derivative. R_f 0.53 (65 : 25 : 4 $CHCl_3$–MeOH–H_2O). HRMS (ESI) calc. for $C_{85}H_{117}N_{11}NiO_{10}S_6$, 1701.6663; found 1701.6694.

[2,3,9,10,16,17-Hexa-(1-hexylthio)-23-((1-(1,4,7,10-tetraoxadodecyl)-1*H*-1,3-triazol-4-yl)methyl α-D-mannopyranoside)]-phthalocyaninato nickel (2-Man). Obtained following method 3 from **17**. Green oily derivative. R_f 0.53 (65 : 25 : 4 $CHCl_3$–MeOH–H_2O). HRMS (ESI) calc. for $C_{85}H_{117}N_{11}NiO_{10}S_6$, 1701.6663; found 1701.6649.

[2,3,9,10,16,17-Hexa-(1-hexylthio)-23-((1-(1,4,7,10-tetraoxadodecyl)-1*H*-1,2,3-triazol-4-yl)methyl β-D-galactopyranoside)]-phthalocyaninato nickel (2-Gal). Obtained following method 3 from **18**. Green oily derivative. R_f 0.53 (65 : 25 : 4 $CHCl_3$–MeOH–H_2O). HRMS (ESI) calc. for $C_{85}H_{117}N_{11}NiO_{10}S_6$, 1701.6663; found 1701.6629.

[2,3,9,10,16,17-Hexa-(1-hexylthio)-23-((1-(1,4,7,10-tetraoxadodecyl)-1*H*-1,2,3-triazol-4-yl)methyl 4-*O*-(β-D-galactopyranosyl)-β-D-glucopyranoside]phthalocyaninato nickel (2-Lac). Obtained following method 3 from **19**. Green oily derivative. R_f 0.20 (65 : 25 : 4 $CHCl_3$–MeOH–H_2O). HRMS (ESI) calc. for $C_{91}H_{127}N_{11}NiO_{15}S_6$, 1863.7191; found 1863.7214.

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