

Indolesulfonyl protecting groups for protection of guanidino and amino groups

The present invention relates to compounds which are useful for the protection of organic compounds comprising at least one guanidino moiety and/or at least one amino group. The invention further relates to a process for the preparation of these compounds and to their use as protecting reagents. The invention also relates to the process for the protecting reaction and to the protected compounds thereof.

Suitable protection of a guanidino moiety is still an unsolved problem in chemistry because of the difficulty to remove the known protecting groups. This applies particularly to peptide chemistry as the natural amino acid arginine, bearing a guanidino moiety, is of great importance for the preparation of numerous drug substances. During the coupling reaction, guanidino protection of arginine is necessary to avoid acylation potentially followed by deguanidation, thus rendering undesired ornithine and δ -lactam formation.

Depending on the coupling strategy, the most commonly used protecting groups for arginine are *p*-toluenesulfonyl (Tos), 2,2,5,7,8-pentamethylchroman-6-sulfonyl (Pmc) and 2,2,4,6,7-pentamethyldihydrobenzofuran-5-sulfonyl (Pbf). However, these protecting groups are too acid-stable, thus requiring harsher removal conditions and a longer removal time. Therefore, the known guanidino protecting groups are prone to form by-products on their removal. Particularly problematic is their cleavage in peptides with multiple arginine residues or in peptides containing tryptophan. Carpino et al. (Tetrahedron Letters **1993**, Vol. 34, No. 49, 7829–7832) compare the Pbf protecting group with the Pmc protecting group when used for arginine side chain protection.

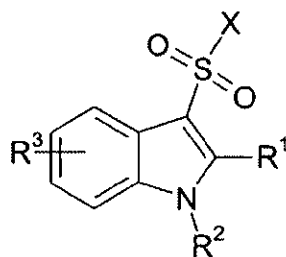
WO 01/57045 discloses tricyclic sulfames obtained via benzofuran-, benzothiophene- and indole-intermediates.

Löwe et al. describe the synthesis of heterocyclic sulfonylureas, which for example comprise an indole moiety (J. Heterocyclic Chem., **1996**, 33, 763–766).

It is an object of the present invention to provide a compound which easily protects the guanidino moiety of an organic compound and which can be easily removed.

The object described above is achieved by the compounds of claim 1, which can be prepared by the process of claim 5 and which is used according to claim 9 in the protection process of claim 12 affording compounds of claim 16.

In one aspect, the present invention relates to a compound of formula



(II),

wherein R¹ is hydrogen, C₁₋₆ alkyl, C₁₋₆ alkoxy or C₁₋₆ alkylthio; R² is C₁₋₆ alkyl, C₁₋₆ alkoxy or C₁₋₆ alkylthio; or R¹ and R² together form a moiety of formula -(CH₂)_n-, wherein n is an integer from 3 to 5; R³ is hydrogen, halogen, C₁₋₆ alkyl, C₁₋₆ alkoxy, C₁₋₆ alkylthio, phenyl or benzyl; and X is chlorine or bromine.

Here and as follows, the term "C_{1-n} alkyl" is to be understood to mean any linear or branched alkyl group containing 1 to n carbon atoms. For example the term "C₁₋₆ alkyl" comprises groups such as methyl, ethyl, propyl, isopropyl, butyl, isobutyl, sec-butyl, *tert*-butyl, pentyl, isopentyl (3-methylbutyl), neopentyl (2,2-dimethylpropyl), hexyl, isohexyl (4-methylpentyl) and the like.

Accordingly, the term "C_{1-n} alkoxy" means a group composed of a C_{1-n} alkyl group as defined above and an oxygen atom linked by a single covalent bond.

In the same manner, the term "C₁₋₆ alkylthio" means a group composed of a C₁₋₆ alkyl group as defined above and an sulfur atom linked by a single covalent bond.

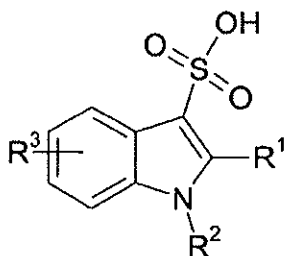
Here and as follows the term "halogen" means fluorine, chlorine, bromine and iodine.

Favourably, the present invention relates to a compound of formula (II), wherein R¹, R², R³ and X are as defined above with the exception of 1-methylindole-3-sulfonyl chloride.

In a preferred embodiment, R¹ and R² are independently C₁₋₄ alkyl, C₁₋₄ alkoxy or C₁₋₄ alkylthio; R³ is hydrogen or halogen; and X is chlorine or bromine.

In a particular embodiment, both R¹ and R² are methyl; R³ is hydrogen; and X is chlorine being 1,2-dimethylindole-3-sulfonyl chloride. For the sake of convenience, this compound will be abbreviated as MIS-Cl.

In a further aspect of the present invention, the compound of formula (II) is prepared by a process comprising the step of reacting a compound of formula



(I),

wherein R¹, R² and R³ are as defined above, or a salt thereof, with oxalyl chloride or oxalyl bromide.

In a preferred embodiment, R¹ and R² are independently C₁₋₄ alkyl, C₁₋₄ alkoxy or C₁₋₄ alkylthio, and R³ is hydrogen or halogen.

In a more preferred embodiment, both R¹ and R² are methyl and R³ is hydrogen.

In the process for the preparation of the compound of formula (II) both the acidic form and the salt form of the compound of formula (I) may be used as reagent. Any salt form of the compound of formula (I) can be applied. Suitable salts are e.g. the sodium salt, the potassium salt, the calcium salt and the pyridinium salt.

In a preferred embodiment, the reaction is performed with the pyridinium salt of the compound of formula (I).

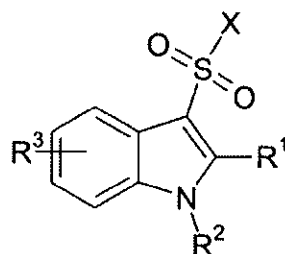
Preferably, oxalyl chloride is applied for the reaction.

For the preparation process, any suitable solvent or mixtures of suitable solvents may be applied. Suitable solvents are solvents which do not react with the reactants or with the product and which dissolve the reactants to a sufficient extent. Examples of suitable solvents are dichloromethane, chloroform, carbon tetrachloride, tetrahydrofuran and 1,4-dioxane. Preferably, dichloromethane is used as solvent.

The reaction may also be performed without a solvent.

Expediently, the reaction is performed in the presence of *N,N*-dimethylformamide.

In an additional aspect of the present invention, the compound of formula



wherein R¹ is hydrogen, C₁₋₆ alkyl, C₁₋₆ alkoxy or C₁₋₆ alkylthio; R² is C₁₋₆ alkyl, C₁₋₆ alkoxy or C₁₋₆ alkylthio; or R¹ and R² together form a moiety of formula -(CH₂)_n-, wherein n is an integer from 3 to 5; R³ is hydrogen, halogen, C₁₋₆ alkyl, C₁₋₆ alkoxy, C₁₋₆ alkylthio, phenyl or benzyl; and X is chlorine or bromine, is used for the protection of an organic compound which comprises at least one guanidino moiety and/or at least one amino group.

In a preferred embodiment, the organic compound is an optionally resin-bound peptidic compound which is optionally side chain protected and/or protected at a free terminus; R¹ and R² are independently C₁₋₄ alkyl, C₁₋₄ alkoxy or C₁₋₄ alkylthio, and R³ is hydrogen or halogen.

Here and in the following, the term "peptidic compound" is to be interpreted in a wide manner as defined hereafter. Therefore, the term "peptidic compound" is to be understood to mean any compound of one of the following categories (a) to (d):

- (a) A peptide, i.e. a compound produced by formation of an amide bond between a carboxyl group of one amino acid and an amino group of another. The amide bond is typically formed between C-1 of one amino acid and N-2 of another (eupeptide bond), but a compound with residues linked by other amide bonds (isopeptide bonds) is also meant to be covered by the term "peptidic compound". Oligopeptides consisting of two to fifteen amino acid residues and polypeptides consisting of sixteen to about fifty amino acid residues are typical peptides of this category. The amino acid residues may be any natural or unnatural amino acids. An example for a peptide is H-Arg-Val-OH.
- (b) An amino acid, which may not only be an amino acid commonly found in proteins (natural α-amino acid) but also any unnatural amino acid. Examples are H-Ala-OH (natural amino acid) and homoarginine (unnatural amino acid).
- (c) A derivative of a peptide, meaning a peptide in which one or more of the amino acid residues have been chemically modified, e.g. by acylation, alkylation, ester formation or amide formation. Examples are Ac-Phe-Arg-Gly-Ala-Val-OH (SEQ

ID NO 5), H-Phe-Arg-Gly-Ala-Val-NH₂ (SEQ ID NO 6) and H-Arg-Gly-Ala-Gly-Gly-Lys(N^ε-tetradecanoyl)-Ala-Gly-Gly-OH (SEQ ID NO 7).

- (d) A derivative of an amino acid, meaning an amino acid which has been chemically modified, e.g. by acylation, alkylation, ester formation or amide formation. An example is H-Ala-OMe.

In another preferred embodiment, the peptidic compound comprises at least one guanidino moiety and optionally at least one amino group, the guanidino moiety being part of an arginine, homoarginine or norarginine residue. More preferably, said
10 guanidino moiety is part of an arginine or homoarginine residue. Even more preferably, the peptidic compound is Z-Arg-OH.

The prefix "homo" to the name of a common amino acid (like homoarginine) means that said amino acid contains one additional methylene group in the carbon chain.

15 In contrast, the prefix "nor" to the name of a common amino acid (like norarginine) denotes removal of one methylene group in the carbon chain.

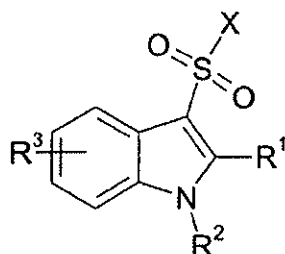
In another preferred embodiment, the peptidic compound comprises at least one
20 amino group and optionally at least one guanidino moiety, said at least one amino group(s) being the N-terminal amino group or part of the side chain of an amino acid residue.

More preferably, the amino group to be protected is the N-terminal amino group of said
25 peptidic compound. Most preferably, the peptidic compound is H-Ala-OMe.

Also more preferably, the amino group to be protected is part of the side chain of an amino acid residue of said peptidic compound. Even more preferably, said amino
30 group is part of a lysine, homolysine or norlysine residue. Most preferably, said peptidic compound is Z-Lys-OH.

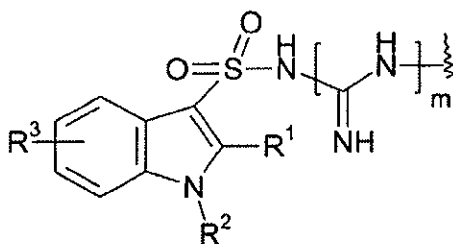
In another aspect, the present invention relates to a process for the protection of an organic compound, which comprises at least one guanidino moiety and/or one amino group,

35 said process comprising the reaction of said compound with the compound of formula



(II),

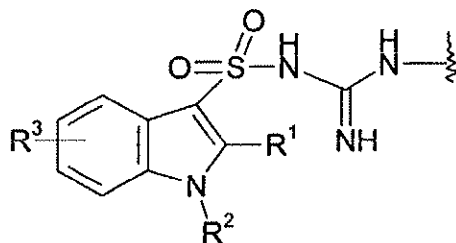
wherein R¹ is hydrogen, C₁₋₆ alkyl, C₁₋₆ alkoxy or C₁₋₆ alkylthio; R² is C₁₋₆ alkyl, C₁₋₆ alkoxy or C₁₋₆ alkylthio; or R¹ and R² together form a moiety of formula -(CH₂)_n-, wherein n is an integer from 3 to 5; R³ is hydrogen, halogen, C₁₋₆ alkyl, C₁₋₆ alkoxy, C₁₋₆ alkylthio, phenyl or benzyl; and X is chlorine or bromine, thus affording a compound, which comprises at least one moiety of the formula



(III),

wherein R¹, R² and R³ are as defined above and m is 0 or 1.

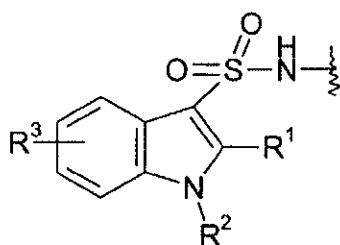
In one embodiment, m is 1, thus affording a compound, which comprises at least one moiety of the formula



(IV),

wherein R¹, R² and R³ are as defined above.

In another embodiment, m is 0, thus affording a compound, which comprises at least one moiety of the formula



(V),

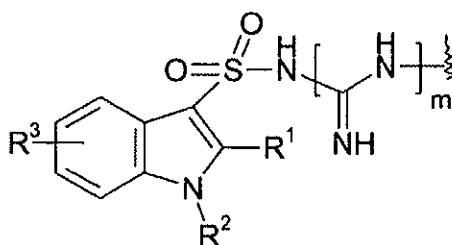
wherein R^1 , R^2 and R^3 are as defined above.

In a preferred embodiment, R^1 and R^2 are independently C_{1-4} alkyl, C_{1-4} alkoxy or C_{1-4} alkylthio, R^3 is hydrogen or halogen. In one embodiment, m is 1 and in another embodiment, m is 0.

In a more preferred embodiment, R^1 and R^2 are methyl, R^3 is hydrogen and X is chlorine. In one embodiment, m is 1; and in another embodiment, m is 0.

In another preferred embodiment, the organic compound is an optionally resin-bound peptidic compound which is optionally side chain protected and/or protected at a free terminus,

thus affording said peptidic compound, which comprises at least one moiety of the formula



(III),

wherein R^1 is hydrogen, C_{1-6} alkyl, C_{1-6} alkoxy or C_{1-6} alkylthio; R^2 is C_{1-6} alkyl, C_{1-6} alkoxy or C_{1-6} alkylthio; or R^1 and R^2 together form a moiety of formula $-(CH_2)_n-$, wherein n is an integer from 3 to 5; and R^3 is hydrogen, halogen, C_{1-6} alkyl, C_{1-6} alkoxy, C_{1-6} alkylthio, phenyl or benzyl; and m is 0 or 1.

Preferably, R^1 and R^2 are independently C_{1-4} alkyl, C_{1-4} alkoxy or C_{1-4} alkylthio and R^3 is hydrogen or halogen. Most preferably, R^1 and R^2 are methyl and R^3 is hydrogen.

In a preferred embodiment, said peptidic compound comprises at least one guanidino moiety being part of an arginine, homoarginine or norarginine residue, preferably being part of an arginine or homoarginine residue,

thus affording said peptidic compound, which comprises at least one moiety of the formula (III), wherein R^1 is hydrogen, C_{1-6} alkyl, C_{1-6} alkoxy or C_{1-6} alkylthio; R^2 is C_{1-6} alkyl, C_{1-6} alkoxy or C_{1-6} alkylthio; or R^1 and R^2 together form a moiety of formula $-(CH_2)_n-$, wherein n is an integer from 3 to 5; and R^3 is hydrogen, halogen, C_{1-6} alkyl, C_{1-6} alkoxy, C_{1-6} alkylthio, phenyl or benzyl; and m is 1;

preferably, wherein R^1 and R^2 are independently C_{1-4} alkyl, C_{1-4} alkoxy or C_{1-4} alkylthio and R^3 is hydrogen or halogen; and more preferably, wherein R^1 and R^2 are methyl and R^3 is hydrogen.

Most preferably, said peptidic compound to be reacted comprises only one guanidino moiety.

In a preferred embodiment, said peptidic compound to be reacted is N- α -benzyloxycarbonyl-L-arginine (Z-Arg-OH).

In an even more preferred embodiment, the peptidic compound to be reacted is Z-Arg-OH; R^1 and R^2 of the compound of formula (II) are methyl, R^3 of the compound of formula (II) is hydrogen and X of the compound of formula (II) is chlorine, thus affording N- α -benzyloxycarbonyl-N- ω -(1,2-dimethylindole-3-sulfonyl)-L-arginine. For the sake of convenience this compound is abbreviated as Z-Arg(MIS)-OH in the following.

In another preferred embodiment, said peptidic compound comprises at least one amino group, said at least one amino group(s) being the N-terminal amino group or being part of the side chain of an amino acid residue,

thus affording said peptidic compound, which comprises at least one moiety of the formula (III), wherein R^1 is hydrogen, C_{1-6} alkyl, C_{1-6} alkoxy or C_{1-6} alkylthio; R^2 is C_{1-6} alkyl, C_{1-6} alkoxy or C_{1-6} alkylthio; or R^1 and R^2 together form a moiety of formula $-(CH_2)_n-$, wherein n is an integer from 3 to 5; and R^3 is hydrogen, halogen, C_{1-6} alkyl, C_{1-6} alkoxy, C_{1-6} alkylthio, phenyl or benzyl; and m is 0;

preferably, wherein R^1 and R^2 are independently C_{1-4} alkyl, C_{1-4} alkoxy or C_{1-4} alkylthio and R^3 is hydrogen or halogen; and

more preferably, wherein R^1 and R^2 are methyl and R^3 is hydrogen.

Most preferably, said peptidic compound to be reacted comprises only one amino group which is the N-terminal amino group or which is part of the side chain of an amino acid residue.

Even more preferably, the amino group of said peptidic compound to be reacted is the N-terminal amino group.

In a preferred embodiment, said peptidic compound to be reacted is L-alanine methyl ester (H-Ala-OMe).

In an even more preferred embodiment, the peptidic compound is H-Ala-OMe; R^1 and R^2 of the compound of formula (II) are methyl, R^3 of the compound of formula (II) is hydrogen and X of the compound of formula (II) is chlorine, thus affording N- α -(1,2-dimethylindole-3-sulfonyl)-L-alanine methyl ester. For the sake of convenience this compound is abbreviated as MIS-Ala-OMe in the following.

Also even more preferably, the amino group of said peptidic compound to be reacted is part of the side chain of an amino acid residue. Most preferably, said amino group is part of a lysine, homolysine or norlysine residue.

As solvent for the protection process, any inert liquid solvent which can dissolve the reactants may be used. Applicable solvents include halogenated hydrocarbons such as dichloromethane, carbon tetrachloride and dichloroethane; ethers such as diethyl ether, tetrahydrofuran, 2-methyltetrahydrofuran; carboxylic esters and lactones such as ethyl acetate, methyl acetate and valerolactone; and organic solvents containing heteroatoms such as acetone, acetonitrile, dimethylformamide and dimethyl sulfoxide. The solvents can be used alone or as mixtures. Optionally, the solvent or solvent mixture may contain water if the solubility of the reactants requires the presence of water. Preferred solvents are dichloromethane and acetone, alone or in the presence of water.

Optionally, the reaction mixture may contain inorganic or organic bases. Examples for inorganic bases are sodium hydroxide, potassium hydroxide, lithium hydroxide and sodium carbonate. Examples for organic bases are diisopropylethylamine, pyridine and triethylamine. Preferred bases are sodium hydroxide and diisopropylethylamine.

The amount of the compound of formula (II) varies with the reactor volume and can be at a molar ratio from 0.9:1 to 4:1, preferably from 1:1 to 3:1, relative to the organic compound, which comprises at least one guanidino moiety and/or one amino group. The compound of formula (II) may be added in portions to the reaction mixture.

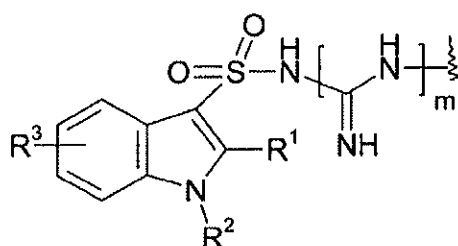
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The protection process may be carried out at low or slightly elevated temperatures. For example, a suitable temperature range is from -10°C to 30°C , preferably from 0°C to room temperature.

10 The reaction time depends on different factors like the temperature or the molar ratio of the compound of formula (II) and the organic compound, which comprises at least one guanidino moiety and/or one amino group. Therefore, the reaction may be completed within a few minutes or several hours.

15 In a further aspect, the present invention relates to an organic compound comprising at least one moiety of the formula

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(III),

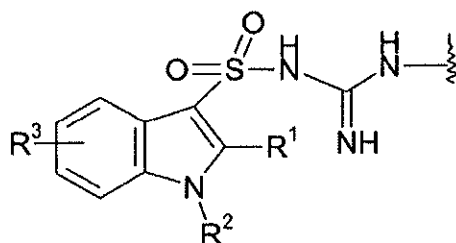
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wherein R^1 is hydrogen, C_{1-6} alkyl, C_{1-6} alkoxy or C_{1-6} alkylthio; R^2 is C_{1-6} alkyl, C_{1-6} alkoxy or C_{1-6} alkylthio; or R^1 and R^2 together form a moiety of formula $-(CH_2)_n-$, wherein n is an integer from 3 to 5; R^3 is hydrogen, halogen, C_{1-6} alkyl, C_{1-6} alkoxy, C_{1-6} alkylthio, phenyl or benzyl; and m is 0 or 1.

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In one embodiment, m is 1, so that the organic compound comprises at least one moiety of the formula

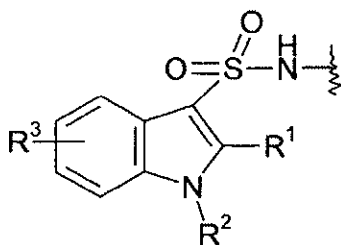
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(IV),

wherein R^1 , R^2 and R^3 are as defined above.

In another embodiment, m is 0, so that the organic compound comprises at least one moiety of the formula



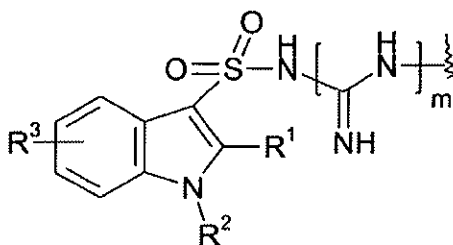
(V),

wherein R^1 , R^2 and R^3 are as defined above.

In a preferred embodiment, R^1 and R^2 are independently C_{1-4} alkyl, C_{1-4} alkoxy or C_{1-4} alkylthio and R^3 is hydrogen or halogen. In one embodiment, m is 1 and in another embodiment, m is 0.

In a more preferred embodiment, R^1 and R^2 are methyl, R^3 is hydrogen and X is chlorine. In one embodiment, m is 1 and in another embodiment, m is 0.

In another preferred embodiment, the organic compound is an optionally resin-bound peptidic compound which is optionally side chain protected and/or protected at a free terminus and which comprises at least one moiety of the formula



(III),

wherein R^1 is hydrogen, C_{1-6} alkyl, C_{1-6} alkoxy or C_{1-6} alkylthio; R^2 is C_{1-6} alkyl, C_{1-6} alkoxy or C_{1-6} alkylthio; or R^1 and R^2 together form a moiety of formula $-(CH_2)_n-$, wherein n is an integer from 3 to 5; R^3 is hydrogen, halogen, C_{1-6} alkyl, C_{1-6} alkoxy, C_{1-6} alkylthio, phenyl or benzyl; and m is 0 or 1, preferably m is 1.

Preferably, R^1 and R^2 are independently C_{1-4} alkyl, C_{1-4} alkoxy or C_{1-4} alkylthio and R^3 is hydrogen or halogen. Most preferably, R^1 and R^2 are methyl and R^3 is hydrogen.

In a preferred embodiment, said peptidic compound comprises at least one guanidino moiety being part of an arginine, homoarginine or norarginine residue, preferably being part of an arginine or homoarginine residue, comprising at least one moiety of the formula (III), wherein R^1 is hydrogen, C_{1-6} alkyl, C_{1-6} alkoxy or C_{1-6} alkylthio; R^2 is C_{1-6} alkyl, C_{1-6} alkoxy or C_{1-6} alkylthio; or R^1 and R^2 together form a moiety of formula $-(CH_2)_n-$, wherein n is an integer from 3 to 5; and R^3 is hydrogen, halogen, C_{1-6} alkyl, C_{1-6} alkoxy, C_{1-6} alkylthio, phenyl or benzyl; and m is 1; preferably, wherein R^1 and R^2 are independently C_{1-4} alkyl, C_{1-4} alkoxy or C_{1-4} alkylthio and R^3 is hydrogen or halogen; and more preferably, wherein R^1 and R^2 are methyl and R^3 is hydrogen.

Most preferably, said peptidic compound comprises only one guanidino moiety.

Even more preferably, said peptidic compound is Z-Arg(MIS)-OH.

In another preferred embodiment, said peptidic compound comprises at least one amino group, said at least one amino group(s) being the N-terminal amino group or being part of the side chain of an amino acid residue, comprising at least one moiety of the formula (III), wherein R^1 is hydrogen, C_{1-6} alkyl, C_{1-6} alkoxy or C_{1-6} alkylthio; R^2 is C_{1-6} alkyl, C_{1-6} alkoxy or C_{1-6} alkylthio; or R^1 and R^2 together form a moiety of formula $-(CH_2)_n-$, wherein n is an integer from 3 to 5; and R^3 is hydrogen, halogen, C_{1-6} alkyl, C_{1-6} alkoxy, C_{1-6} alkylthio, phenyl or benzyl; and m is 0; preferably, wherein R^1 and R^2 are independently C_{1-4} alkyl, C_{1-4} alkoxy or C_{1-4} alkylthio and R^3 is hydrogen or halogen; and more preferably, wherein R^1 and R^2 are methyl and R^3 is hydrogen.

Also more preferably, said peptidic compound comprises only one amino group which is the N-terminal amino group or which is part of the side chain of an amino acid residue.

Even more preferably, the amino group of said peptidic compound is the N-terminal amino group.

Most preferably, said peptidic compound is MIS-Ala-OMe.

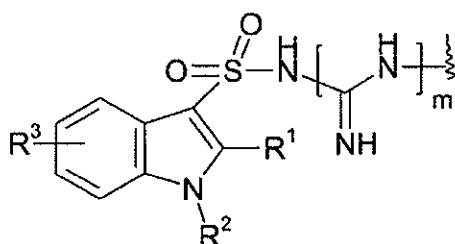
Also even more preferably, the amino group of said peptidic compound is part of the side chain of an amino acid residue. Most preferably, said amino group is part of a lysine, homolysine or norlysine residue.

- 5 A further aspect of the invention is modifying and/or coupling in following step(s) the organic compound obtained according to the present invention.

As the organic compounds obtained according to the present invention are important building blocks, they can be applied to form organic compounds being useful as e.g.
10 drug substances.

According to the present invention, the organic compound which comprises at least one moiety of the formula

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(III),

wherein R^1 is hydrogen, C_{1-6} alkyl, C_{1-6} alkoxy or C_{1-6} alkylthio; R^2 is C_{1-6} alkyl, C_{1-6} alkoxy or C_{1-6} alkylthio; or R^1 and R^2 together form a moiety of formula $-(CH_2)_n-$, wherein n is an integer from 3 to 5; R^3 is hydrogen, halogen, C_{1-6} alkyl, C_{1-6} alkoxy, C_{1-6} alkylthio, phenyl or benzyl; and m is 0 or 1,
25 is chemically modified in a following step.

In a preferred embodiment, the organic compound to be modified in a following step is an optionally resin-bound peptidic compound which is optionally side chain protected
30 and/or protected at a free terminus and which comprises at least one moiety of the formula (III), wherein R^1 , R^2 , R^3 and m are as defined above.

Preferably, said peptidic compound comprises at least one guanidino moiety being part of an arginine, homoarginine or norarginine residue, preferably being part of an arginine or homoarginine residue, comprising at least one moiety of the formula (III),
35 wherein R^1 , R^2 , R^3 and m are as defined above;
preferably, wherein R^1 and R^2 are independently C_{1-4} alkyl, C_{1-4} alkoxy or C_{1-4} alkylthio and R^3 is hydrogen or halogen; and

more preferably, wherein R^1 and R^2 are methyl and R^3 is hydrogen.

Most preferably, said peptidic compound comprises only one guanidino moiety.

5 Even more preferably, said peptidic compound is Z-Arg(MIS)-OH.

Modification comprises any organic reaction which complies with the protecting group of the present invention. As an example, Z-Arg(MIS)-OH may be modified by deprotection of the Z group, thus forming H-Arg(MIS)-OH.

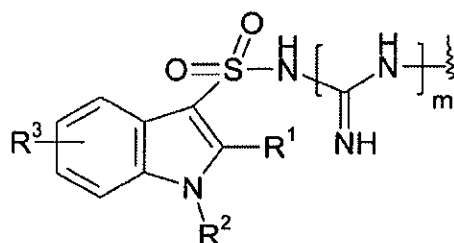
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Optionally, the modified compound thus obtained is at least once further modified. As an example, H-Arg(MIS)-OH as obtained by a first modification may be further modified by protection of its N-terminus, thus forming e.g. Fmoc-Arg(MIS)-OH.

15 The deprotection and protection steps can be carried out using reaction conditions known in the art of peptide synthesis.

Also according to the present invention, the organic compound which comprises at least one moiety of the formula

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25

(III),

wherein R^1 is hydrogen, C_{1-6} alkyl, C_{1-6} alkoxy or C_{1-6} alkylthio; R^2 is C_{1-6} alkyl, C_{1-6} alkoxy or C_{1-6} alkylthio; or R^1 and R^2 together form a moiety of formula $-(CH_2)_n-$, wherein n is an integer from 3 to 5; R^3 is hydrogen, halogen, C_{1-6} alkyl, C_{1-6} alkoxy, C_{1-6} alkylthio, phenyl or benzyl; and m is 0 or 1, is coupled to an organic compound Q in a following step.

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Optionally, said coupling step may be repeated at least once and/or at least one further coupling with a suitable coupling compound may be performed. The compound thus obtained may be chemically modified and in case said compound is resin-bound, cleavage from the resin may follow.

35

In a preferred embodiment, the organic compound to be coupled in a following step to the organic compound Q is an optionally resin-bound peptidic compound which is optionally side chain protected and/or protected at a free terminus and which comprises at least one moiety of the formula (III), wherein R^1 , R^2 , R^3 and m are as defined above.

Preferably, said peptidic compound comprises at least one guanidino moiety being part of an arginine, homoarginine or norarginine residue, preferably being part of an arginine or homoarginine residue, comprising at least one moiety of the formula (III), wherein R^1 , R^2 , R^3 and m are as defined above; preferably, wherein R^1 and R^2 are independently C_{1-4} alkyl, C_{1-4} alkoxy or C_{1-4} alkylthio and R^3 is hydrogen or halogen; and more preferably, wherein R^1 and R^2 are methyl and R^3 is hydrogen.

Most preferably, said peptidic compound comprises only one guanidino moiety.

Even more preferably, said peptidic compound is Fmoc-Arg(MIS)-OH or Z-Arg(MIS)-OH.

The organic compound Q is preferably an optionally resin-bound peptidic compound which is optionally side chain protected and/or protected at a free terminus. Most preferably, the organic compound Q is a peptidic compound which is optionally side chain protected and which is optionally resin-bound.

In a preferred embodiment, said peptidic compound is H-Val-resin or H-Trp(Boc)-Ala-Gly-resin, preferably the resin originates from the Sieber amide resin (9-Fmoc-amino-xanthen-3-yloxy-Merrifield resin).

In an even more preferred embodiment, the peptidic compound to be coupled is Fmoc-Arg(MIS)-OH and the peptidic compound to which said peptidic compound is coupled is H-Val-NH-xanthen-3-yloxy-Merrifield resin, thus affording Fmoc-Arg(MIS)-Val-NH-xanthen-3-yloxy-Merrifield resin.

Preferably, said coupling reaction is repeated three times thus affording Fmoc-Arg(MIS)-Arg(MIS)-Arg(MIS)-Arg(MIS)-Val-NH-xanthen-3-yloxy-Merrifield resin (SEQ ID NO 8). Also preferably, Fmoc-Phe-OH is coupled after N-terminal deprotection of said resin-bound peptide, thus affording Fmoc-Phe-Arg(MIS)-Arg(MIS)-Arg(MIS)-Arg(MIS)-Val-NH-xanthen-3-yloxy-Merrifield resin (SEQ ID NO 1). More preferably, the

N-terminus is deprotected and acetylated, thus affording Ac-Phe-Arg(MIS)-Arg(MIS)-Arg(MIS)-Arg(MIS)-Val-NH-xanthen-3-yloxy-Merrifield resin (SEQ ID NO 1). Most preferably said resin-bound peptide is cleaved from the resin, thus affording Ac-Phe-Arg(MIS)-Arg(MIS)-Arg(MIS)-Arg(MIS)-Val-NH₂ (SEQ ID NO 2).

5

In an also even more preferred embodiment, the peptidic compound to be coupled is Z-Arg(MIS)-OH and the peptidic compound to which said compound is coupled is H-Trp(Boc)-Ala-Gly-NH-xanthen-3-yloxy-Merrifield resin, thus affording Z-Arg(MIS)-Trp(Boc)-Ala-Gly-NH-xanthen-3-yloxy-Merrifield resin (SEQ ID NO 3). Preferably, said
10 resin-bound peptide is cleaved from the resin, thus affording Z-Arg(MIS)-Trp(Boc)-Ala-Gly-NH₂ (SEQ ID NO 3).

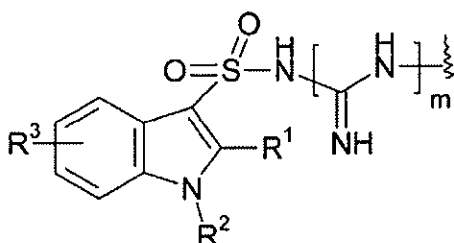
The coupling procedure to the organic compound Q may follow according to any coupling method known to the person skilled in the art. In case the organic compound
15 to be coupled is a peptidic compound, coupling is preferably performed in solid or liquid phase. Most preferably, optionally preceding and optionally following coupling steps are also performed in solid and/or liquid phase.

The term "solid phase" is to be understood to mean solid phase peptide synthesis (SPPS). In SPPS an amino acid or peptide group, optionally protected, is bound to a
20 solid support resin. Then, successive amino acids or peptide groups, optionally protected, are attached to the support-bound peptide until the peptide material of interest is formed. The support-bound peptide is then typically cleaved from the support and subject to further processing and/or purification. In some cases, solid
25 phase synthesis yields a mature peptide product; in other cases the peptide cleaved from the support, i.e. a "peptide intermediate fragment", is used in the preparation of a larger, mature peptidic product.

The term "solution phase" is to be understood to mean solution phase peptide
30 synthesis. In solution phase peptide synthesis, two peptide intermediate fragments, optionally protected, or a peptide intermediate fragment and a reactive amino acid, both optionally protected, are coupled in an appropriate solvent, usually in the presence of additional reagents that promote the efficiency and quality of the coupling reaction. The peptide intermediate fragments are reactively arranged so that the
35 N-terminal of one fragment becomes coupled to the C-terminal of the other fragment, or vice versa. In addition, side chain protecting groups, which are present during solid phase synthesis, are commonly retained on the fragments during solution phase coupling to ensure the specific reactivity of the terminal ends of the fragments. These

side chain protecting groups are typically not removed until a mature peptidic compound has been formed.

A further aspect of the invention is the cleavage of an organic compound, comprising
5 at least one moiety of the formula



(III),

15 wherein R^1 is hydrogen, C_{1-6} alkyl, C_{1-6} alkoxy or C_{1-6} alkylthio; R^2 is C_{1-6} alkyl, C_{1-6} alkoxy or C_{1-6} alkylthio; or R^1 and R^2 together form a moiety of formula $-(CH_2)_n-$, wherein n is an integer from 3 to 5; R^3 is hydrogen, halogen, C_{1-6} alkyl, C_{1-6} alkoxy, C_{1-6} alkylthio, phenyl or benzyl; and m is 0 or 1, said cleavage optionally taking place in the presence of at least one scavenger.

20 In a preferred embodiment, the cleavage procedure is performed by use of an acid, preferably by use of trifluoroacetic acid (TFA). The acid is applied neat or as mixture with an inert solvent.

An example for a suitable inert solvent is dichloromethane (DCM). Preferably, the
25 molar ratio of acid and solvent is in the range from 1:0 and 1:2, preferably from 1:0 and 1:1.

After cleavage, the formed sulfonylium compound may be trapped by any suitable scavenger. Examples for scavengers are triisopropylsilane (TIS), water, dimethyl
30 sulfide, C_{1-4} alkoxybenzenes such as 1,3,5-trimethoxybenzene (TMB) and C_{1-4} alkoxyphenols such as 3,4-dimethoxyphenol and 3,5-dimethoxyphenol. The scavenger may be used alone or as mixture such as water/TIS.

Preferably, C_{1-4} alkoxybenzenes and C_{1-4} alkoxyphenols are used as scavengers as they are less polar nucleophiles compared to e.g. water. As a consequence, the
35 adducts thus obtained are easier to separate from the target compound in the following work-up procedure.

In a preferred embodiment, said organic compound to be cleaved is an optionally resin-bound peptidic compound which is optionally side chain protected and/or protected at a free terminus. Preferably, R¹ and R² are independently C₁₋₄ alkyl, C₁₋₄ alkoxy or C₁₋₄ alkylthio and R³ is hydrogen or halogen, most preferably, R¹ and R² are methyl and R³ is hydrogen.

In a more preferred embodiment, said peptidic compound to be cleaved is Ac-Phe-Arg(MIS)-Arg(MIS)-Arg(MIS)-Arg(MIS)-Val-NH-xanthen-3-yloxy-Merrifield resin (SEQ ID NO 1), thus affording Ac-Phe-Arg-Arg-Arg-Arg-Val-NH₂ (SEQ ID NO 2). Preferably, TFA/DCM/TIS/water is applied as cleavage solution, most preferably in a molar ratio of 50:45:2.5:2.5. Also preferably, TFA/DCM/3,4-dimethoxyphenol is applied as cleavage solution, most preferably in a molar ratio of 50:40:10. Also preferably, TFA/DCM/3,5-dimethoxyphenol is applied as cleavage solution, most preferably in a molar ratio of 50:40:10. Also preferably, TFA/DCM/TMB is applied as cleavage solution, most preferably in a molar ratio of 50:40:10.

In an also more preferred embodiment, said peptidic compound to be cleaved is Z-Arg(MIS)-Trp(Boc)-Ala-Gly-NH-xanthen-3-yloxy-Merrifield resin (SEQ ID NO 3), thus affording Z-Arg-Trp-Ala-Gly-NH₂ (SEQ ID NO 4). Preferably, TFA/DCM/TMB is applied as cleavage solution, most preferably in a molar ratio of 50:40:10.

In an also more preferred embodiment, said peptidic compound to be cleaved is MIS-Ala-OMe, thus affording H-Ala-OMe. Preferably, TFA/dimethyl sulfide is applied as cleavage solution, most preferably in a molar ratio of 90:10.

Examples

The following examples further illustrate this invention but are not intended to limit it in any way. Examples 1 to 8 refer to preparation procedures and Examples 9 to 20 refer to removal assays.

If not indicated otherwise, the L-enantiomer of the amino acid residue was used and all reagents were obtained commercially.

Abbreviations:

Boc = *tert*-butoxycarbonyl

DIC = diisopropylcarbodiimide

DIPEA = diisopropylethylamine

ESMS = electrospray mass spectrometry

Fmoc = fluoren-9-ylmethoxycarbonyl

HOAt = *N*-hydroxy-7-azabenzotriazole

HOBt = *N*-hydroxybenzotriazole

HRMS (CI) = high resolution mass spectrometry (chemical ionization)

5 MALDI-TOF = matrix-assisted laser desorption ionization-time of flight

MIS = 1,2-dimethylindol-3-sulfonyl

PyBOP = benzotriazol-1-yloxy-tripyrrolidinophosphonium hexafluorophosphate

TFA = trifluoroacetic acid

TIS = triisopropylsilane

10 TMB = 1,3,5-trimethoxybenzene

Z-OSu = *N*-(benzyloxycarbonyloxy)succinimide

Example 1: Preparation of pyridinium 1,2-dimethylindole-3-sulfonate

1,2-Dimethylindole (19.7 g, 135.9 mmol) and sulfur trioxide pyridine complex (20.4 g,
15 128.3 mmol) were dissolved in pyridine (100 mL) under argon atmosphere. The
reaction mixture was refluxed for 40 hours and then cooled down to room temperature.
After addition of water (400 mL), the resulting solution was washed four times with
diethyl ether (each 250 mL). The aqueous phase was evaporated to dryness and dried
in the vacuum desiccator to render pyridinium 1,2-dimethylindole-3-sulfonate as red oil
20 (37.6 g, 96% yield).

¹H NMR (400 MHz, D₂O): δ = 8.44 (d, 2H, J = 5.8 Hz), 8.31 (m, 1H), 7.75 (m, 2H), 7.67
(d, 1H, J = 7.7 Hz), 7.14 (d, 1H, J = 7.4 Hz), 7.05 (m, 2H), 3.38 (s, 3H), 2.41 (s, 3H).

¹³C NMR (100 MHz, D₂O): δ = 147.0, 140.9, 139.2, 135.6, 127.3, 124.1, 122.0, 121.0,
25 119.2, 112.8, 109.9, 29.2, 10.4.

HRMS (CI): *m/z* calc. for C₁₀H₁₀NO₃S [M - H]⁺ 224.0386, found 224.0388.

Example 2: Preparation of 1,2-dimethylindole-3-sulfonyl chloride (MIS-Cl)

Pyridinium 1,2-dimethylindole-3-sulfonate of Example 1 (16.4 g, 53.7 mmol) was
30 suspended in dry dichloromethane (120 mL) under nitrogen atmosphere. The solution
was cooled in an ice bath and oxalyl chloride (14 mL, 161 mmol) was slowly added.
Then, *N,N*-dimethylformamide (0.5 mL) was very slowly added under stirring. The
reaction mixture was stirred for further 30 minutes in the ice bath and then at room
temperature. After 6 hours, the solution was cooled down in an ice bath. Extra oxalyl
35 chloride (4 mL, 46 mmol) and *N,N*-dimethylformamide (0.4 mL) were added and the
reaction mixture was stirred at room temperature for further 15 hours. After addition of
oxalyl chloride (2 mL, 23 mmol) and further stirring for 4 hours, the reaction was

completed (measured by HPLC; prior measurement, treatment of a small aliquot with methanol for 20 minutes).

The reaction mixture was evaporated to dryness at room temperature. *N,N*-dimethylformamide (200 mL) was added, followed by water (100 mL). The mixture was stirred for 5 minutes to remove the oxalyl chloride. Then, the phases were separated and the organic phase was washed three times with water (each 100 mL). The organic phase was dried over anhydrous magnesium sulfate and evaporated to dryness affording 1,2-dimethylindole-3-sulfonyl chloride (MIS-Cl) as purple solid (10.2 g, 78% yield).

¹H NMR (400 MHz, DMSO): δ = 7.82 (d, 1H, *J* = 7.8 Hz), 7.36 (d, 1H, *J* = 8.0 Hz), 7.08 (m, 2H), 7.00 (m, 2H), 3.63 (s, 3H), 2.56 (s, 3H).

¹³C NMR (100 MHz, DMSO): δ = 137.2, 135.9, 125.5, 121.4, 120.8, 120.1, 109.7, 30.0, 11.3.

HRMS (CI): *m/z* calc. for C₁₀H₁₀NO₂S [M - Cl]⁺ 208.0426, found 208.0427.

Example 3: Preparation of Z-Arg(MIS)-OH

Z-Arg-OH (2 g, 6.5 mmol) was dissolved in acetone (65 mL) and 3N aqueous sodium hydroxide solution (18 mL, 54 mmol). The reaction was cooled in an ice bath and MIS-Cl of Example 2 (1.59 g, 6.5 mmol), dissolved in acetone (50 mL), was added during 10 minutes. The reaction mixture was stirred for 1 hour at 0 °C. Then, additional MIS-Cl (0.95 g, 3.9 mmol) in acetone (20 mL) was added, followed by stirring for 90 minutes at 0 °C. Finally, a last portion of MIS-Cl (0.95 g, 3.9 mmol) in acetone (15 mL) was added. The reaction mixture was stirred for additional 30 minutes at 0 °C and further 3 hours at room temperature, until no MIS-Cl was detected by TLC (hexane:ethyl acetate 1:1). The pH of the reaction was neutralized with 10% aqueous citric acid. After evaporation of the acetone in vacuo, water (100 mL) was added and the pH was acidified to pH 3 with 10% aqueous citric acid. Then, the solution was three times extracted with ethyl acetate (each 100 mL). The organic phases were put together, washed three times with water (each 75 mL), dried over magnesium sulfate and finally evaporated to dryness. The crude obtained was purified twice by column chromatography (dichloromethane, methanol, acetic acid). The pure fractions were combined and the solvent was removed in vacuo yielding an oil. For precipitation, the minimum amount of a mixture of ethyl acetate, dichloromethane and methanol was added followed by addition of hexane until no further precipitation was observed. The solvent was decanted and the solid was washed four times with a mixture of dichloromethane and hexane and finally dried over magnesium sulfate yielding 18% (0.61 g) of Z-Arg(MIS)-OH.

¹H NMR (400 MHz, DMSO): δ = 7.85 (d, 1H, J = 7.6 Hz), 7.52 (d, 1H, J = 8.0 Hz), 7.43 (d, 1H, J = 8.0 Hz), 7.30 (m, 5H), 7.10 (m, 2H), 5.01 (s, 2H), 3.87 (m, 1H), 3.66 (s, 3H), 3.0 (m, 2H), 2.60 (s, 3H), 1.64 (m, 1H), 1.49 (m, 1H), 1.41 (m, 2H).

¹³C NMR (100 MHz, DMSO): δ = 174.4, 157.0, 156.8, 139.4, 137.7, 135.9, 129.0, 128.5, 128.4, 125.2, 122.1, 121.1, 120.1, 110.4, 66.1, 54.3, 40.0, 30.2, 28.9, 26.4, 11.4.

HRMS (CI): *m/z* calc. for C₂₄H₃₀N₅O₆S [M + H]⁺ 516.1911, found 516.1911.

10 **Example 4: Preparation of Fmoc-Arg(MIS)-OH**

1. Preparation of H-Arg(MIS)-OH

A mixture of Z-Arg(MIS)-OH as obtained from Example 3 (486 mg, 0.94 mmol) and 10% Pd/C (110 mg) in methanol (60 mL) was hydrogenated overnight at atmospheric pressure. As the reaction was still incomplete (measured by TLC; dichloromethane: methanol:acetic acid, 90:9:1), 10% Pd/C (100 mg) was added and the reaction was hydrogenated for further 24 hours till completeness (measured by TLC).

The reaction mixture was filtered over celite and evaporated to dryness yielding 98% (352 mg) of H-Arg(MIS)-OH.

¹H NMR (400 MHz, DMSO): δ = 7.83 (d, 1H, J = 7.6 Hz), 7.47 (d, 1H, J = 8.1 Hz), 7.42 (d, 1H, J = 8.1 Hz), 7.11 (m, 2H), 3.65 (s, 3H), 3.17 (m, 1H), 3.00 (m, 2H), 2.60 (s, 3H), 1.65 (m, 1H), 1.54 (m, 1H), 1.42 (m, 2H).

25 2. Preparation of Fmoc-Arg(MIS)-OH

Fmoc-Cl (84 mg, 0.32 mmol) was dissolved in 1,4-dioxane (0.5 mL). Sodium azide (25 mg, 0.39 mmol) in water (0.4 mL) was added and the resulting emulsion was stirred for 2 hours at room temperature. Then, the emulsion was slowly added to a solution of H-Arg(MIS)-OH as obtained in the previous step (136 mg, 0.36 mmol) in a 1:1 mixture of water and dioxane at pH 9, which was controlled by addition of 10% aqueous sodium carbonate. The reaction mixture was stirred while keeping the pH at 9. Once the pH was stabilized, the mixture was stirred overnight. Then, water (30 mL) was added and the mixture was washed three times with *tert*-butyl methyl ether (each 20 mL). The aqueous phase was acidified with 1N HCl to a pH of 2 to 3 and was then quickly extracted three times with ethyl acetate (30 mL). The organic phases were combined and dried over magnesium sulfate. After evaporation to dryness, an oil (115 mg) was obtained, which was dissolved in a minimum of acetone. Then, aqueous sodium carbonate (20 mL) was added at pH 9 and the aqueous solution was washed

three times with *tert*-butyl methyl ether (each 30 mL). The aqueous solution thus obtained was acidified with 1N HCl to a pH of 2 to 3, then extracted three times with ethyl acetate (each 20 mL), dried over magnesium sulfate and finally evaporated to dryness yielding 34.3% (67.4 mg) of Fmoc-Arg(MIS)-OH.

5

¹H NMR (400 MHz, DMSO): δ = 7.86 (m, 3H), 7.70 (d, 2H, J = 7.4 Hz), 7.59 (d, 1H, J = 7.9 Hz), 7.42 (d, 1H, J = 8.1 Hz), 7.39 (m, 2H), 7.30 (m, 2H), 7.10 (m, 2H), 4.27 (m, 2H), 4.20 (m, 1H), 3.86 (m, 1H), 3.66 (s, 3H), 3.01 (m, 2H), 2.61 (s, 3H), 1.65 (m, 1H), 1.52 (m, 1H), 1.38 (m, 2H).

10

¹³C NMR (100 MHz, DMSO): δ = 174.4, 157.0, 156.8, 144.5, 141.4, 139.4, 135.9, 128.3, 127.8, 126.0, 125.2, 122.1, 121.1, 120.8, 120.1, 110.4, 66.3, 55.6, 47.3, 40.0, 30.2, 28.8, 26.5, 11.4.

HRMS (CI): m/z calc. for C₃₁H₃₄N₅O₆S [M + H]⁺ 604.2224, found 604.2222.

15

Example 5: Preparation of Ac-Phe-Arg(MIS)-Arg(MIS)-Arg(MIS)-Arg(MIS)-Val-NH₂ (SEQ ID NO 2)

Sieber amide resin (25 mg, 0.42 mmol/g, 9-Fmoc-aminoxanthen-3-yloxy-Merrifield resin) was placed in a 2 mL polypropylene syringe fitted with a polyethylene filter disk. The resin was swollen with dichloromethane. Subsequently, washings with

20

dichloromethane and *N,N*-dimethylformamide were carried out and the Fmoc group was removed by treatment with a 2:8 mixture of piperidine and *N,N*-dimethylformamide (once for 1 minute, and two times for 10 minutes). Fmoc-Val-OH (14.3 mg, 42.1 μ mol) was coupled using HOBt (5.7 mg, 42.1 μ mol) and DIC (6.7 μ L, 42.1 μ mol) in

25

N,N-dimethylformamide for 1.5 hours. The Fmoc group was removed in the usual way, and Fmoc-Arg(MIS)-OH as obtained from Example 4 (15.8 mg, 26.3 μ mol) was

coupled using PyBOP (13.7 mg, 26.3 μ mol), HOAt (3.6 mg, 26.3 μ mol) and DIPEA (13.4 μ L, 78.9 μ mol) in *N,N*-dimethylformamide for 90 minutes. The resin was acetylated by treatment with acetic anhydride (50 eq) and DIPEA (50 eq) in DMF for

30

25 min in order to do the capping of the unreacted amines, the Fmoc group was removed and the same procedure was repeated three more times including acetylation of the resin prior to Fmoc removal. After the last Fmoc removal, Fmoc-Phe-OH

(13.6 mg, 35 μ mol) was coupled using PyBOP (18.3 mg, 35 μ mol), HOAt (4.8 mg, 35 μ mol) and DIPEA (17.9 μ L, 105.2 μ mol) in *N,N*-dimethylformamide for 90 min. The Fmoc group was removed, and the resulting free amino group was acetylated in the

35

same way as described above. The protected, resin-bound peptide Ac-Phe-Arg(MIS)-Arg(MIS)-Arg(MIS)-Arg(MIS)-Val-NH-xanthen-3-yloxy-Merrifield resin thus obtained was washed with *N,N*-dimethylformamide, dichloromethane and diethyl ether, dried *in vacuo* and then divided into five aliquots.

One aliquot was used for the preparation of the target compound of this example and the other aliquots were used as starting material for the removal assays of e.g. Example 9.

Thus, one aliquot was swollen with dichloromethane and treated with 1.5 mL of a mixture of TFA, dichloromethane, TIS and water (2:93:2.5:2.5) for 20 minutes in order to cleave the protected peptide from the resin. The resin was filtered and the collected solution was diluted with dichloromethane and neutralized by adding DIPEA (80 μ L, 1.2 eq per eq of TFA). The solvent was removed *in vacuo*. After addition of water and acetonitrile, the solution was lyophilized obtaining Ac-Phe-Arg(MIS)-Arg(MIS)-Arg(MIS)-Arg(MIS)-Val-NH₂ (SEQ ID NO 2).

The product was characterized by LC-MS and HRMS (CI): *m/z* calc. for C₈₀H₁₀₇N₂₃O₁₅S₄ [M + Na]⁺ 1780.7092, found 1780.7152.

Example 6: Preparation of Z-Arg(MIS)-Trp(Boc)-Ala-Gly-NH₂ (SEQ ID NO 4)

Sieber amide resin (70 mg, 0.40 mmol/g) was placed in a 2 mL polypropylene syringe fitted with a polyethylene filter disk. The resin was swollen with dichloromethane, washings with dichloromethane and *N,N*-dimethylformamide were carried out and the Fmoc group was removed. Fmoc-Gly-OH (33.3 mg, 112 μ mol), Fmoc-Ala-OH (34.9 mg, 112 μ mol) and Fmoc-Trp(Boc)-OH (59.0 mg, 112 μ mol) were sequentially coupled using PyBOP (58.3 mg, 112 μ mol) HOAt (15.2 mg, 112 μ mol) and DIPEA (57.4 μ L, 336 μ mol) in *N,N*-dimethylformamide for 1.5 hours. The resin was divided into two equal parts. One part was used for the preparation of the target compound of this example and the other part for the preparation of Z-Arg(Pbf)-Trp(Boc)-Ala-Gly-NH₂ (see Example 8.2).

Thus, Z-Arg(MIS)-OH (28.9 mg, 56 μ mol) was coupled with one resin part using PyBOP (29.2 mg, 56 μ mol), HOAt (7.6 mg, 56 μ mol) and DIPEA (28.7 μ L, 168 μ mol) in *N,N*-dimethylformamide for 1.5 hours. The protected, resin-bound peptide Z-Arg(MIS)-Trp(Boc)-Ala-Gly-NH-xanthen-3-yloxy-Merrifield resin thus obtained was washed with *N,N*-dimethylformamide, dichloromethane and diethyl ether, dried *in vacuo* and then divided into aliquots of 4 mg. One aliquot was used for the preparation of the target compound of this example and the other aliquots were used as starting material for the removal assays of e.g. Example 19.

Thus, one aliquot was swollen with dichloromethane and treated with 1.5 mL of a mixture of TFA, dichloromethane, TIS and water (2:93:2.5:2.5) for 20 minutes in order to cleave the protected peptide from the resin. The resin was filtered and the collected solution was diluted with dichloromethane and neutralized by adding DIPEA (80 μ L, 1.2 eq per eq of TFA). The solvent was removed *in vacuo*. After addition of water and

acetonitrile, the solution was lyophilized obtaining Z-Arg(MIS)-Trp(Boc)-Ala-Gly-NH₂ with 95% purity (by HPLC). The product obtained was characterized by LC-MS.

Example 7: Preparation of MIS-Ala-OMe

5 H-Ala-OMe (95 mg, 0.68 mmol, 1 eq) was dissolved in dry dichloromethane and DIPEA (3 eq) was added. A solution of MIS-Cl (200 mg, 1.2 eq), as obtained from Example 2, in dry dichloromethane was added, and the reaction mixture was stirred for 1.5 hours at room temperature. Work up in the usual way yielded 85.4 mg (40%) of MIS-Ala-OMe.

Example 8: Preparation of the Pbf protected comparison compounds

8.1 Preparation of Ac-Phe-Arg(Pbf)-Arg(Pbf)-Arg(Pbf)-Arg(Pbf)-Val-NH₂ (SEQ ID NO 2)

15 The same procedure as for the preparation of Ac-Phe-Arg(MIS)-Arg(MIS)-Arg(MIS)-Arg(MIS)-Val-NH₂ was applied (see Example 5) except for replacing Fmoc-Arg(MIS)-OH by Fmoc-Arg(Pbf)-OH (17.1 mg, 26.3 µmol). The product obtained was characterized by LC-MS and HRMS (CI): *m/z* calc. for C₉₂H₁₃₆N₁₉O₁₉S₄ [M + H]⁺
20 1938.9137, found 1938.9202.

8.2 Preparation of Z-Arg(Pbf)-Trp(Boc)-Ala-Gly-NH₂ (SEQ ID NO 4)

Fmoc-Arg(Pbf)-OH (36.3 mg, 56 µmol) was coupled with the other resin part from Example 6 using PyBOP (29.2 mg, 56 µmol), HOAt (7.6 mg, 56 µmol) and DIPEA
25 (28.7 µL, 168 µmol) in *N,N*-dimethylformamide for 1.5 hours. The Fmoc group was removed and the free amine was protected with the Z group by treatment with Z-OSu (14.0 mg, 56 µmol) and DIPEA (35.9 µL, 210 µmol). The protected, resin-bound peptide Z-Arg(Pbf)-Trp(Boc)-Ala-Gly-NH-xanthen-3-yloxy-Merrifield resin thus obtained was washed with *N,N*-dimethylformamide, dichloromethane and diethyl ether, dried *in vacuo*, and then divided into aliquots of 4 mg.
30

One aliquot was used for the preparation of the target compound of this example and the other aliquots were used as starting material for the removal assay of e.g. Example 20.

Thus, one aliquot was cleaved in the same way as described in Example 5.

35 Z-Arg(Pbf)-Trp(Boc)-Ala-Gly-NH₂ was obtained with 96% purity (by HPLC). The product was characterized by LC-MS.

8.3 Preparation of Pbf-Ala-OMe

Preparation was performed analogous to Example 7 except for Pbf-Cl (1.2 eq) instead of MIS-Cl. Yield: 209 mg (82%) of Pbf-Ala-OMe.

5

Examples 9 to 12: Removal assays of MIS versus Pbf protected, resin-bound peptides

10 General procedure

The protected, resin-bound peptide (3 mg) was treated with cleavage solution (50 μ L). After the cleavage time, the solution was poured into water (4 mL). Then, TFA and dichloromethane were evaporated. The resulting aqueous solution was washed six times with dichloromethane (each 1 mL) and lyophilized. The resulting solid was
15 analyzed by HPLC (λ = 220 nm) and ESMS or MALDI-TOF.

Table 1: Examples 9 to 12 with cleavage solution TFA/DCM/TIS/water (50:45:2.5:2.5) (water and TIS as scavengers)

Example	Protected, resin bound peptide	Cleavage time	Ac-Phe-Arg-Arg-Arg-Arg-Val-NH ₂ (SEQ ID NO 2)
9	a	30 min	100%
10	a	60 min	100%
11	b	30 min	4%
12	b	60 min	38%

- 20 **a** = Ac-Phe-Arg(MIS)-Arg(MIS)-Arg(MIS)-Arg(MIS)-Val-NH-xanthen-3-yloxy-Merrifield resin (SEQ ID NO 1) as obtained from Example 5.
b = Ac-Phe-Arg(Pbf)-Arg(Pbf)-Arg(Pbf)-Arg(Pbf)-Val-NH-xanthen-3-yloxy-Merrifield resin (SEQ ID NO 1) as obtained from Example 8.1 (comparison example).
25 DCM = Dichloromethane.

Examples 13 to 15: Removal assays of MIS protected, resin-bound peptides with different scavengers

- 30 The general procedure as described in Examples 9 to 12 was followed. As protected, resin-bound peptide Ac-Phe-Arg(MIS)-Arg(MIS)-Arg(MIS)-Arg(MIS)-Val-NH-xanthen-3-

yloxy-Merrifield resin (SEQ ID NO 1), as obtained from Example 5, was used. The cleavage time was 60 minutes. A mixture of TFA, dichloromethane and scavenger (50:40:10) was used as cleavage solution.

- 5 The scavengers tested were 3,4-dimethoxyphenol (Example 13), 1,3,5-trimethoxybenzene (TMB) (Example 14) and 3,5-dimethoxyphenol (Example 15).

As a result, the amount of MIS-OH was reduced by more than 10 times compared to Example 9, in which water (2.5%) and TIS (2.5%) were used as scavengers. In the
10 case of Tmb, a reduction by more than 40 times was even observed.

Examples 16 and 17: Removal assays of MIS versus Pbf protected, resin-bound, Trp-containing peptides

- 15 The general procedure as described in Examples 9 to 12 was followed. The resulting crudes were characterized by LC-MS and its purity was analyzed by HPLC ($\lambda = 220 \text{ nm}$).

The purity of the resulted crude was higher for the MIS protected starting material compared to the Pbf protected starting material. For both protected peptides c and d,
20 neither undesired Trp alkylation nor sulfonation was observed in the formed product.

Table 2: Examples 16 and 17; with cleavage solution TFA/DCM/TMB (50:40:10) (TMB as scavenger)

Example	Protected, resin bound peptide	Cleavage time	Z-Arg-Trp-Ala-Gly-NH ₂ (SEQ ID NO 4)
16	c	60 min	83.4%*
17	d	60 min	63.4%*

25 c = Z-Arg(MIS)-Trp(Boc)-Ala-Gly-NH-xanthen-3-yloxy-Merrifield resin (SEQ ID NO 3) as obtained from Example 6.

d = Z-Arg(Pbf)-Trp(Boc)-Ala-Gly-NH-xanthen-3-yloxy-Merrifield resin (SEQ ID NO 3) as obtained from Example 8.2 (comparison example).

DCM = Dichloromethane — TMB = 1,3,5-trimethoxybenzene — * Z-Arg(MIS)-Trp-Ala-Gly-NH₂ (SEQ ID NO 4) was not detected in the resulting crude (by LC-MS) —
30 *20.4% of Z-Arg(Pbf)-Trp-Ala-Gly-NH₂ (SEQ ID NO 4) was detected in the resulting crude (by HPLC).

Examples 18 to 20: Removal assays of MIS versus Pbf as N^α-amino protecting groups

The protected amino acids were treated with the cleavage solution at room temperature and the deprotection was followed by TLC.

MIS removal was slightly faster, presenting a positive Kaiser test (indicating the presence of free amines) after 5 min, whereas for the case of Pbf the positive Kaiser test was in the next control (10 min).

Table 3: Examples 18 to 20; with cleavage solution TFA/dimethyl sulfide (90:10) (dimethyl sulfide as scavenger)

Example	Protected peptide	Cleavage time	H-Ala-OMe ⁺
18	e	5 min	detected
19	f	5 min	not detected
20	f	10 min	detected

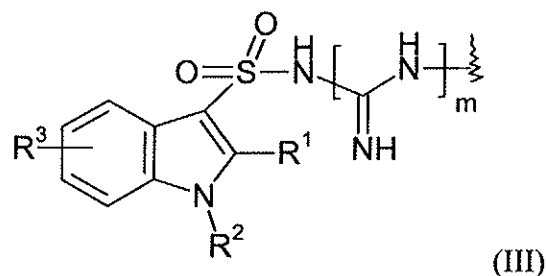
e = MIS-Ala-OMe as obtained from Example 7.

f = Pbf-Ala-OMe as obtained from Example 8.3 (comparison example).

⁺ Presence or absence of H-Ala-OMe was detected by the Kaiser test.

Claims

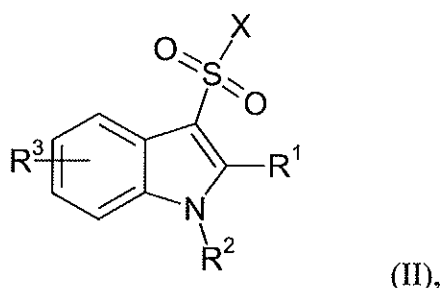
1. A peptidic compound comprising at least one moiety of the formula (III), said formula (III) being defined as follows:



wherein R^1 is hydrogen, C_{1-6} alkyl, C_{1-6} alkoxy or C_{1-6} alkylthio; R^2 is C_{1-6} alkyl, C_{1-6} alkoxy or C_{1-6} alkylthio; or R^1 and R^2 together form a moiety of formula $-(CH_2)_n-$, wherein n is an integer from 3 to 5; R^3 is hydrogen, halogen, C_{1-6} alkyl, C_{1-6} alkoxy, C_{1-6} alkylthio, phenyl or benzyl; and X is chlorine or bromine; and wherein m is 0 or 1.

2. The compound of claim 1, wherein the peptidic compound is resin-bound peptidic compound.
3. The compound of claim 1, wherein the peptidic compound is side chain protected and/or protected at a free terminus.
4. The compound of claim 1 wherein said compound is N-alpha-benzyloxycarbonyl-N-omega-(1,2-dimethylindole-3-sulfonyl)-L-arginine.
5. The compound of claim 1 wherein said compound is N-alpha-Fmoc-N-omega-(1,2-dimethylindole-3-sulfonyl)-L-arginine.
6. A process for the preparation of the peptidic compound as defined in claim 1,

comprising the step of reacting a peptidic compound having at least one guanidino moiety and/or at least one amino group, with a compound of formula (II), said compound of formula (II) being defined as follows:



wherein R^1 , R^2 , and R^3 are as defined in claim 1, and X is chlorine or bromine.

7. The process of claim 6, wherein R^1 and R^2 are independently C_{1-4} alkyl, C_{1-4} alkoxy or C_{1-4} alkylthio and R^3 is hydrogen or halogen.
8. The process of claim 6, wherein R^1 and R^2 are methyl, R^3 is hydrogen and X is chlorine.
9. The process of claim 6, wherein the peptidic compound having at least one guanidino moiety and/or at least one amino group is a resin-bound peptidic compound.
10. The process of claim 6, wherein the peptidic compound having at least one guanidino moiety and/or at least one amino group is side chain protected and/or protected at a free terminus.