CLAIMS

1. Use of a peptide and/or peptidomimetic, capable of self-assembling and forming a hydrogel, having the general formula I:

$$\boldsymbol{Z_a\text{-}(X)_b\text{-}(Y)_c\text{-}Z'_d}$$

(I)

wherein

Z is an N-terminal protecting group;

a is 0 or 1, preferably 1;

X is, at each occurrence, independently selected from the group consisting of aliphatic amino acids and aliphatic amino acid derivatives, and wherein the overall hydrophobicity decreases from N- to C-terminus;

b is an integer selected from 1 to 7;

Y is selected from the group consisting of polar amino acids and polar amino acid derivatives;

c is 1 or 2;

Z' is a C-terminal protecting group; and

d is 0 or 1,

and **b** + **c** is at least 2,

as a non-linear optical (NLO) material for second harmonic generation (SHG) microscopyand/or *in vitro* (bio-)imaging .

2. The use according to claim 1, wherein said aliphatic amino acids and aliphatic amino acid derivatives, and said polar amino acids and polar amino acid derivatives are either D-amino acids or L-amino acids, wherein optionally, said aliphatic amino acids are selected from the group consisting of alanine (Ala, A), homoallylglycine, homopropargylglycine, isoleucine (Ile, I), norleucine, leucine (Leu, L), valine (Val, V) and glycine (Gly, G), preferably from the group consisting of alanine (Ala, A), isoleucine (Ile, I), leucine (Leu, L), valine (Val, V) and glycine (Gly, G) and/or

wherein all or a portion of said aliphatic amino acids are arranged in an order of decreasing amino acid size in the direction from N- to C-terminus, wherein the size of the aliphatic amino acids is defined as I = L > V > A > G.

3. The use according to claim 1 or 2, wherein said aliphatic amino acids have a sequence selected from

LIVAG (SEQ ID NO: 1),
ILVAG (SEQ ID NO: 2),
ILVAA (SEQ ID NO: 3),
LIVAA (SEQ ID NO: 4),
LAVAG (SEQ ID NO: 5),
IAVAG (SEQ ID NO: 6),
AIVAG (SEQ ID NO: 7),
GIVAG (SEQ ID NO: 8),
VIVAG (SEQ ID NO: 9),
ALVAG (SEQ ID NO: 10),
GLVAG (SEQ ID NO: 11),
VLVAG (SEQ ID NO: 12),
IVAG (SEQ ID NO: 13),
LIVA (SEQ ID NO: 14),
LIVG (SEQ ID NO: 15),
ILVA (SEQ ID NO: 16),
ILVG (SEQ ID NO: 17),
LVAG (SEQ ID NO: 18),
IVA
IVG,
VIG,
IVA,
VIA,
IV and
VI.

4. The use according to any of the foregoing claims, wherein **b** is an integer from 2 to 7 or 2 to 6.

5. The use according to any of the foregoing claims, wherein said polar amino acids are selected from the group consisting of aspartic acid (Asp, D), asparagine (Asn, N), glutamic acid (Glu, E), glutamine (Gln, Q), 5-N-ethyl-glutamine (theanine), citrulline, thio-citrulline, cysteine (Cys, C), homocysteine, methionine (Met, M), ethionine, selenomethionine, telluromethionine, threonine (Thr, T), allothreonine, serine (Ser, S), homoserine, arginine (Arg, R), homoarginine, ornithine (Orn), lysine (Lys, K), N(6)-carboxymethyllysine, histidine (His, H), 2,4-diaminobutyric acid (Dab), 2,3-diaminopropionic acid (Dap), and N(6)-carboxymethyllysine,
wherein said polar amino acid is preferably selected from the group consisting of aspartic acid, asparagine, glutamic acid, glutamine, serine, threonine, methionine, lysine, ornithine (Orn), 2,4-diaminobutyric acid (Dab), and 2,3-diaminopropionic acid (Dap).

6. The use according to any of the foregoing claims, wherein **c** is 2 and said polar amino acids are identical amino acids,
or wherein **c** is 1 and said polar polar amino acid comprises any one of aspartic acid, asparagine, glutamic acid, glutamine, serine, threonine, cysteine, methionine, lysine, ornithine, 2,4-diaminobutyric acid (Dab) and histidine,
preferably lysine, ornithine, 2,4-diaminobutyric acid (Dab) and 2,3-diaminopropionic acid (Dap).

7. The use according to any of the foregoing claims, wherein $\mathbf{(Y)_c}$ has a sequence selected from Asp, Asn, Glu, Gln, Ser, Thr, Cys, Met, Lys, Orn, Dab, His, Asn-Asn, Asp-Asp, Glu-Glu, Gln-Gln, Asn-Gln, Gln-Asn, Asp-Gln, Gln-Asp, Asn-Glu, Glu-Asn, Asp-Glu, Glu-Asp, Gln-Glu, Glu-Gln, Asp-Asn, Asn-Asp Thr-Thr, Ser-Ser, Thr-Ser, Ser-Thr, Asp-Ser, Ser-Asp, Ser-Asn, Asn-Ser, Gln-Ser, Ser-Gln, Glu-Ser, Ser-Glu, Asp-Thr, Thr-Asp, Thr-Asn, Asn-Thr, Gln-Thr, Thr-Gln, Glu-Thr, Thr-Glu, Cys-Asp, Cys-Lys, Cys-Ser, Cys-Thr, Cys-Orn, Cys-Dab, Cys-Dap, Lys-Lys, Lys-Ser, Lys-Thr, Lys-Orn, Lys-Dab, Lys-Dap, Ser-Lys, Ser-Orn, Ser-Dab, Ser-Dap, Orn-Lys, Orn-Orn, Orn-Ser, Orn-Thr, Orn-Dab, Orn-Dap, Dab-Lys, Dab-Ser, Dab-Thr, Dab-Orn, Dab-Dab, Dab-Dap, Dap-Lys, Dap-Ser, Dap-Thr, Dap-Orn, Dap-Dab, Dap-Dap.

8. The use according to any of the foregoing claims, wherein $(X)_b$-$(Y)_c$ has a sequence selected from the group consisting of

LIVAGD (SEQ ID NO: 19),
ILVAGD (SEQ ID NO: 20),
ILVAAD (SEQ ID NO: 21),
LIVAAD (SEQ ID NO: 22),
LAVAGD (SEQ ID NO: 23),
IAVAGD (SEQ ID NO: 24),
AIVAGD (SEQ ID NO: 25),
LIVAGE (SEQ ID NO: 26),
LIVAGK (SEQ ID NO: 27),
ILVAGK (SEQ ID NO. 28),
ILVAAK (SEQ ID NO: 29),
IAVAGK (SEQ ID NO: 30),
AIVAGK (SEQ ID NO: 31),
LIVAGT (SEQ ID NO: 32),
ILVAAT (SEQ ID NO: 33),
IAVAGT (SEQ ID NO: 34),
AIVAGT (SEQ ID NO: 35),
LIVAD (SEQ ID NO: 36),
LIVGD (SEQ ID NO: 37),
ILVAD (SEQ ID NO: 38),
ILVGD (SEQ ID NO: 39),
LVAGD (SEQ ID NO: 40),
IVAD (SEQ ID NO: 41),
IVAK (SEQ ID NO: 42),
IVGD (SEQ ID NO: 43),
VIGD (SEQ ID NO: 44),
IVAD (SEQ ID NO: 45),
VIAD (SEQ ID NO: 46),
IVGK (SEQ ID NO: 47),
VIGK (SEQ ID NO: 48),

IVAK (SEQ ID NO: 49),

VIAK (SEQ ID NO: 50),

IIID (SEQ ID NO: 51),

IIIK (SEQ ID NO: 52),

IVD,

IVK,

IID,

LVE,

IVE,

LVD,

VIE,

VID,

VIK,

VLD,

VLE,

LLE,

LLD,

IIE,

ID,

IE,

LIVAGOrn (SEQ ID NO: 53),

ILVAGOrn (SEQ ID NO: 54),

ILVAAOrn (SEQ ID NO: 55),

IAVAGOrn (SEQ ID NO: 56),

AIVAGOrn (SEQ ID NO: 57),

LIVAGDab (SEQ ID NO: 58),

ILVAGDab (SEQ ID NO: 59),

ILVAADab (SEQ ID NO: 60),

IAVAGDab (SEQ ID NO: 61),

AIVAGDab (SEQ ID NO: 62),

LIVAGDap (SEQ ID NO: 63),

ILVAGDap (SEQ ID NO: 64),

ILVAADap (SEQ ID NO: 65),

IAVAGDap (SEQ ID NO: 66),
AIVAGDap (SEQ ID NO: 67),
LIVAOrn (SEQ ID NO: 68),
LIVGOrn (SEQ ID NO: 69),
ILVAOrn (SEQ ID NO: 70),
ILVGOrn (SEQ ID NO: 71),
LVAGOrn (SEQ ID NO: 72),
LIVADab (SEQ ID NO: 73),
LIVGDab (SEQ ID NO: 74),
ILVADab (SEQ ID NO: 75),
ILVGDab (SEQ ID NO: 76),
LVAGDab (SEQ ID NO: 77),
LIVADap (SEQ ID NO: 78),
LIVGDap (SEQ ID NO: 79),
ILVADap (SEQ ID NO: 80),
ILVGDap (SEQ ID NO: 81),
LVAGDap (SEQ ID NO: 82),
IVAOrn (SEQ ID NO: 83),
IVGOrn (SEQ ID NO: 84),
VIGOrn (SEQ ID NO: 85),
IVAOrn (SEQ ID NO: 86),
VIAOrn (SEQ ID NO: 87),
IVADab (SEQ ID NO: 88),
IVGDab (SEQ ID NO: 89),
VIGDab (SEQ ID NO: 90),
IVADab (SEQ ID NO: 91),
VIADab (SEQ ID NO: 92),
IVADap (SEQ ID NO: 93),
IVGDap (SEQ ID NO: 94),
VIGDap (SEQ ID NO: 95),
IVADap (SEQ ID NO: 96),
VIADap (SEQ ID NO: 97),
IVOrn,

IVDab,

IVDap,

VIOrn,

VIDab,

VIDap, and

ILVAGS (SEQ ID NO: 98).

9. Use of a peptide having the general formula II:

$$\boldsymbol{Z}_{\mathbf{a}}\text{-}\mathbf{M}\text{-}\boldsymbol{Z}'_{\mathbf{d}}$$

(II)

wherein

Z is an N-terminal protecting group;

a is 0 or 1, preferably 1;

M is an amino acid sequence selected from SEQ ID Nos. 99 to 102;

Z' is a C-terminal protecting group; and

d is 0 or 1,

as a non-linear optical (NLO) material for second harmonic generation (SHG) microscopyand/or *in vitro* (bio-)imaging.

10. The use according to any of the foregoing claims, wherein **a** is 1 and said N-terminal protecting group ***Z*** has the general formula –C(O)–R, wherein R is selected from the group consisting of H, unsubstituted or substituted alkyls, and unsubstituted or substituted aryls,.

wherein R is preferably selected from the group consisting of methyl, ethyl, propyl, isopropyl, butyl and isobutyl.

11. The use according to any of the foregoing claims, wherein said N-terminal protecting group ***Z*** is an acetyl group,

or wherein said N-terminal protecting group ***Z*** is a peptidomimetic molecule, including natural and synthetic amino acid derivatives, wherein the N-terminus of said peptidomimetic molecule may be modified with a functional group selected from the

group consisting of carboxylic acid, amide, alcohol, aldehyde, amine, imine, nitrile, an urea analog, phosphate, carbonate, sulfate, nitrate, maleimide, vinyl sulfone, azide, alkyne, alkene, carbohydrate, imide, peroxide, ester, aryl, ketone, sulphite, nitrite, phosphonate, and silane.

12. The use according to any of the foregoing claims, wherein said C-terminal protecting group ***Z'*** optionally comprises:

(a) an amide group,

wherein, preferably, the C-terminus has the formula -CONHR or -CONRR', with R and R' being selected from the group consisting of H, unsubstituted or substituted alkyls, and unsubstituted or substituted aryls;

(b) an ester group,

wherein, preferably, the C-terminus has the formula $-CO_2R$, with R being selected from the group consisting of H, unsubstituted or substituted alkyls, and unsubstituted or substituted aryls; or

(c) a peptidomimetic molecule, including natural and synthetic amino acid derivatives, wherein the C-terminus of said peptidomimetic molecule may be modified with a functional group selected from the group consisting of carboxylic acid, amide, alcohol, aldehyde, amine, imine, nitrile, an urea analog, phosphate, carbonate, sulfate, nitrate, maleimide, vinyl sulfone, azide, alkyne, alkene, carbohydrate, imide, peroxide, ester, aryl, ketone, sulphite, nitrite, phosphonate, and silane.

13. The use according to any one of claims 1 to 8, and 10-14, wherein **b** + **c** is at least 2, preferably 2 to 9, more preferably 3 to 7 or 2 to 7.

14. The use according to any of the foregoing claims, wherein the peptide and/or peptidomimetic is visualized under a second harmonic generation (SHG) microscopy without additional dye(s) and/or label(s).

15. The use according to any of the foregoing claims, wherein the peptide and/or peptidomimetic comprises further compound(s), such as

- small molecules,

such as (but not limited to) sugars, alcohols, hydroxy acids, amino acids, vitamins, biotin, L-Dopa, thyroxine;

- bioactive molecules or moieties,

such as growth factors, cytokines, lipids, cell receptor ligands, hormones, prodrugs, drugs, vitamins, antigens, antibodies, antibody fragments, oligonucleotides (including but not limited to DNA, messenger RNA, short hairpin RNA, small interfering RNA, microRNA, peptide nucleic acids, aptamers), saccharides;

- label(s), dye(s),

such as imaging contrast agents;

- pathogens,

such as viruses, bacteria and parasites;

- micro- and nanoparticles

or combinations thereof

which are preferably covalently attached or coupled to the peptide and/or peptidomimetic, preferably to the C-terminal group ***Z'***, amino acid side chain(s) and/or linker,

wherein said attachment or coupling can be carried out before, during or after self-assembly of the peptide and/or peptidomimetic.

16. The use according to any of the foregoing claims, wherein the at least one peptide and/or peptidomimetic as defined in any one of claims 1 to 15 forms a fibrous structure, which is preferably tunable, such as

- in the way of peptide material's preparation (fiber structures, particle structures),

- for excitation wavelength tunability of SHG signals, wherein preferably the fibrous structure is a fibrous scaffold resembling the collagen fiber in extracellular matrix.

17. The use according to any of the foregoing claims, wherein the at least one peptide and/or peptidomimetic as defined in any one of claims 1 to 15 is stable in aqueous solution at physiological conditions at ambient temperature for a period of time in the range from 1 day to at least 6 months, preferably to at least 8 months more preferably to at least 12 months, and/or

wherein the peptide and/or peptidomimetic is present at a concentration in the range of from 0.1 % to 30 % (w/w), preferably 0.1 % to 20 % (w/w), more preferably 0.1 % to 10

% (w/w), more preferably 0.1 % to 5 % (w/w), even more preferably 0.1 % to 3 % (w/w), with respect to the total weight of said hydrogel or fibrous structure.

18. The use according to any of claims 1 to 24, wherein a hydrogel, fibrous structure or peptide particle is obtained by dissolving at least one peptide and/or peptidomimetic as defined in any one of claims 1 to 8 and 10 to 15 in an aqueous solution., for probes; and/or . for monitoring cells, and/or
for visualizing peptide-based tissue engineering scaffolds,
preferably comprising studying biological processes, such as cell adhesion, migration and differentiation; and/or
for *in vitro* detection of aggregation of peptide or protein structures,
such as amyloidosis, including

- neuro-degenerative amyloidosis, e.g. Alzheimer's (AD), Parkinson's, Huntington's (PD),
- non-neuropathic localized amyloidosis such as in Type II Diabetes, and
- systemic amyloidosis that occurs in multiple tissues, e.g. cataracts and lattice corneal dystrophy (LCD).

19. A peptide particle comprising the peptide and/or peptidomimetic as defined in any one of claims 1 to 15, wherein the peptide particle comprises a particle size in the range from submicron to 10 microns and is tunable, such as

- in the way of peptide particle's preparation, for excitation wavelength tunability of SHG signals.

20. A peptide-based tissue engineering scaffold comprising the peptide and/or peptidomimetic as defined in any one of claims 1 to 15, wherein the scaffold is tunable, such as

- in the way of peptide-based tissue engineering scaffold's preparation, for excitation wavelength tunability of SHG signals.

21. A biosensor or bioimaging device comprising the peptide and/or peptidomimetic as defined in any one of claims 1 to 15, wherein the biosensor or bioimaging device is tunable, such as

- in the way of biosensor or bioimaging device's preparation, for excitation wavelength tunability of SHG signals.

22. A wound dressing comprising the peptide and/or peptidomimetic as defined in any one of claims 1 to 15, wherein the wound dressing is tunable, such as

- in the way of wound dressing's preparation, for excitation wavelength tunability of SHG signals.