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Bioinspired synthesis of biomolecule-derived fluorescent nanodots from natural amino acids with enhanced photo-stability, biocompatibility and cellular uptake

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Natural amino acids possess different side chain R groups which make them excellent precursors for programmable synthesis of biomolecule-derived fluorescent nanodots (bio-dots) with desired properties. In order to establish the material design rules, 20 amino acids-derived bio-dots were synthesized via hydrothermal treatment and comprehensively characterized. We discovered that the properties of the bio-dots are determined by their unique side chain functional groups. Amino acids such as Arg, His, Asp, Asn, Ser and Thr with reactive side chains including amine, hydroxyl and carboxyl functional groups give rise to bright bio-dots with quantum yield >15%. The length of the side chains is also critical in determining the final morphology (e.g., nanodot, nanowire or nanomesh) and consequently the photoluminescent properties of the bio-dots. It is worthy to note that hydroxyl-containing amino acids (i.e., Ser and Thr) form highly photostable bio-dots with negligible intensity reduction upon UV exposure. Selective mixing of specific amino acid precursors (such as Ser with Arg) leads to the formation of hybrid bio-dots which exhibit enhanced photostability photo-stability with significant red-shift in their emission wavelength. Furthermore, cell studies demonstrate that the bio-dots displayed outstanding biocompatibility and excellent intracellular uptake, which are highly desirable for fluorescence imaging applications. As such, bioinspired synthesis of bio-dots provides a versatile route for customizable development of nanoscale biomaterials by design.

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