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PAPER

Blue-luminescent 5-(3-indolyl)oxazoles *via* microwave-assisted three-component coupling–cycloisomerization–Fischer indole synthesis†‡

Oliver Grotkopp,[a] Atia Ahmad,[a] Walter Frank[b] and Thomas J. J. Müller*[a]

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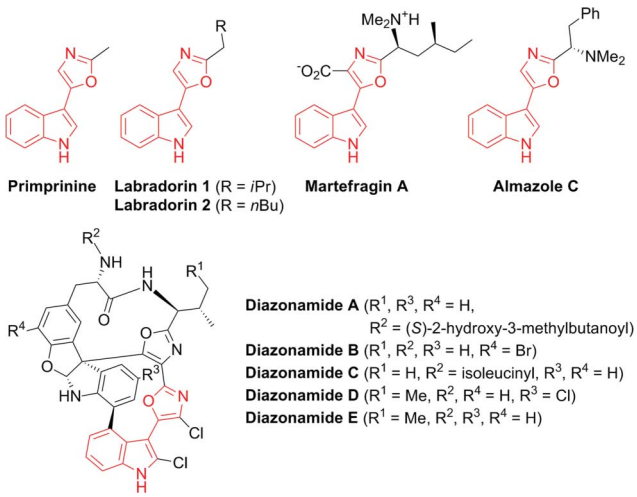
Aryl-substituted 5-(3-indolyl)oxazoles are readily synthesized in a novel one-pot three-component synthesis consisting of a microwave assisted sequence of Sonogashira coupling, an acid-catalyzed cycloisomerization, and a concluding Fischer indole synthesis. All title compounds are intensely blue-luminescent with large Stokes shifts upon UV-irradiation. The experimental absorption spectra are rationalized by ZINDO-CI computations based upon DFT geometry optimization.

Introduction

Indolyl oxazoles consist of two prominent heterocycles, indoles and oxazoles, which are conjugatively ligated *via* a carbon–carbon bond. In particular, the 5-(3-indolyl)oxazole framework is encountered in naturally occurring alkaloids from various bacterial sources or marine ascidians with substitution patterns ranging from simple, as for pimprinine[1] or labradorins,[2] to intermediate, as for martefragin A[3] and almazole C,[4] to quite complex, as for the family of polymacrocyclic lactams such as the diazonamides[5] (Scheme 1).

Most remarkably, a broad spectrum of biological activity extends from high cytotoxicity against several human tumor cell lines and antimitotic behavior by inhibition of tubulin assembly of the complex diazonamides[5,6] to antioxidant activity of martefragin A[7] and antimicrobial and anticancer activity of the labradorins.[2] Even the structurally simplest alkaloid, pimprinine, has turned out to inhibit monoamine oxidase (MAO), it behaves as an antiepileptic by protecting against electrically induced convulsions and inhibition against tremors and analgesia induced by the chemical tremorine.[8] As a consequence several synthetic strategies for the rapid formation of the 5-(3'-indolyl)oxazole framework have been developed in the past decade.[7,9]

In recent years the productive concept of multicomponent reactions (MCR) adopted a central position for satisfying the increasing demand for new scaffolds for pharmaceuticals and



Scheme 1 Naturally occurring 5-(3-indolyl)oxazole alkaloids.

biologically active compounds.[10] These one-pot processes are highly advantageous because they combine shortened reaction times and resource efficiency with diminished waste production compared to traditional multistep syntheses. Thus, they can be considered as economically and ecologically benign.[11]

In particular, multicomponent syntheses of heterocycles initiated by transition metal catalysis have been increasingly developed in the past decade.[12] Over the years we have advanced this concept by virtue of Pd/Cu-catalyzed accesses to enones and ynones and the *in situ* transformation of these intermediates into many classes of heterocycles.[13] In particular, these novel MCRs represent a diversity-oriented strategy towards functional organic chromophores.[14] Here, we report a novel consecutive three-component synthesis of 5-(3-indolyl)oxazoles based upon a one-pot concatenation of Sonogashira coupling, cycloisomerization, and a concluding Fischer indole synthesis, thereby forming both heterocyclic moieties, oxazole and indole, in a *de novo* fashion. In addition we present first photophysical studies on the

[a]*Lehrstuhl für Organische Chemie, Institut für Organische Chemie und Makromolekulare Chemie, Heinrich-Heine-Universität Düsseldorf, Universitätsstraße 1, D-40225, Düsseldorf, Germany. E-mail: ThomasJJ.Mueller@uni-duesseldorf.de; Fax: +49 (0)211 8114324; Tel: +49 (0)211 8112298*
[b]*Institut für Anorganische Chemie und Strukturchemie, Heinrich-Heine-Universität Düsseldorf, Universitätsstraße 1, D-40225, Düsseldorf, Germany*

† Electronic supplementary information (ESI) available: Spectra (^{1}H NMR, ^{13}C NMR, UV/Vis, fluorescence) of compound **4**, computed *xyz*-coordinates of structure **4x**, and X-ray structure analysis summary of compound **4x**. CCDC reference number 834591. For ESI and crystallographic data in CIF or other electronic format see DOI: 10.1039/c1ob06153d

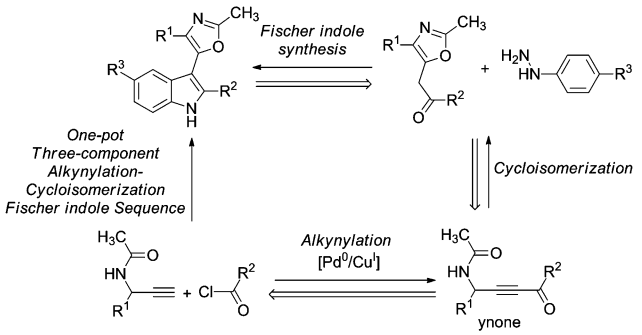
‡ Dedicated to Prof. Dr. Claus A. M. Seidel on the occasion of his 50th birthday

luminescence behavior of the title compounds and computations on the electronic structure.

Results and discussion

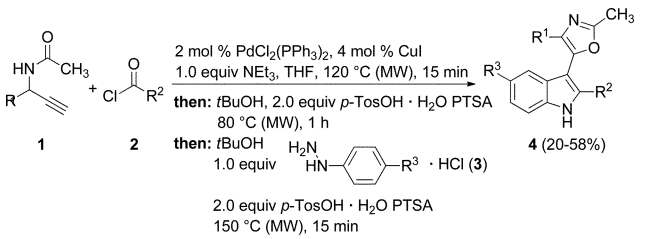
Synthesis

Our retrosynthetic analysis of aryl substituted 5-(3-indolyl)oxazoles (Scheme 2) commences with a terminal Fischer indole transform leading back to 1-(hetero)aryl-2-(2-methyl-4-(hetero)aryl-oxazol-5-yl) ethanones. Among numerous indole syntheses[15] Fischer's classical indole synthesis[16] has remained a reliable and highly practical ethanone to indole transformation, which is still very popular for the synthesis of many indole derivatives. Although many oxazole forming syntheses[17] have been reported, the standard syntheses of 2,5-diaryloxazoles under the conditions of cyclodehydration are relatively harsh. Therefore, milder methods for the preparation of highly functionalized oxazoles are apparently more attractive.[18] In particular, cycloisomerization of propargyl amides can lead to 2,5-disubstituted oxazoles by acid or base catalysis. Furthermore, palladium catalyzed coupling of aryl iodides in the presence of sodium *tert*-butoxide,[19] or gold catalysis[20] is equally well suited. We have recently reported an efficient three-component amidation–coupling–cycloisomerization sequence *via* an intermediate of propargylamide ynone.[21] Therefore, our retrosynthetic analysis of 1-(hetero)aryl-2-(2-methyl-4-(hetero)aryl-oxazol-5-yl) ethanones disconnects directly back to propargyl acetamides and (hetero)aroyl chlorides. By virtue of this conceived strategy, three elements of diversity can be introduced by forming four new bonds in a one-pot fashion. For the synthetic realization we decided to accelerate the sequence by performing each step under dielectric heating.[22]



Scheme 2 Retrosynthetic analysis aryl substituted 5-(3-indolyl)oxazoles *via* a one-pot three-component approach.

Upon reaction of 1-(aryl) *N*-(prop-2-yn-1yl)acetamides **1** and (hetero)aroyl chlorides **2** under modified Sonogashira conditions[23] in the microwave cavity at 120 °C for a hold time of 15 min the *in situ* generated ynones were cycloisomerized after addition of *p*-toluene sulfonic acid (PTSA) and *t*-BuOH and dielectric heating at 80 °C for a hold time of 1 h to give the 1-(hetero)aryl-2-(2-methyl-4-(hetero)aryl-oxazol-5-yl) ethanones (monitored by TLC). After addition of another aliquot of PTSA and aryl hydrazine hydrochlorides **3** to the reaction mixture, the same reaction vessel was heated in a microwave oven at 150 °C for a hold time of 15 min to furnish, after isolation and chromatographic purification,



Scheme 3 Three-component microwave assisted coupling–cycloisomerization–Fischer indole synthesis of aryl substituted 5-(3-indolyl)oxazoles **4**.

the aryl substituted 5-(3-indolyl)-oxazoles **4** as colorless to pale yellow crystals in 20–58% yield (Scheme 3, Fig. 1).

The latter step is easy to monitor by TLC, since the product **4** is intensely blue luminescent in contrast to the precursor intermediates and the applied reactants, which are only weak yet detectable emitters. Reaction times shorter than 15 min resulted in incomplete conversion and led to lower yields, whereas prolonged reaction times essentially did not affect the yields.

All structures of the aryl substituted 5-(3-indolyl)-oxazoles **4** were unambiguously supported by spectroscopic characterization (^{1}H, ^{13}C, mass spectrometry) and combustion analysis, and later the molecular structure was additionally corroborated by an X-ray crystal structure analysis of compound **4x** (Fig. 2).[24] Most interestingly, the crystal structure reveals an infinite chain of hydrogen bonded 5-(3-indolyl)-oxazoles established by bridges of 3.084 Å length and an angle of 159° between the indolyl NH as a hydrogen donor and the oxazolyl nitrogen atom as a hydrogen bond acceptor. The oxazole and the indole planes are twisted from coplanarity by an angle of 46.7° and the indole plane and the aromatic substituent R^2 display a torsional angle of 41.8°.

The product analysis of the 5-(3-indolyl)oxazoles **4** clearly reveals the influence of the electronic nature of the propargylic substituent R^1 on the yields. The *p*-chlorophenyl substituted *N*-(prop-2-yn-1yl)acetamide **1a** is transformed to give higher average yields (36–58%) in comparison to the *p*-tolyl substituted substrate **1b** (24–47%). This effect can be attributed to the cycloisomerization step of the sequence, where the deprotonation of the propargylic position essentially terminates the oxazole formation.

Another interesting electronic effect is attributed to the acid chloride **2** as a coupling partner. In combination with electron neutral or electron rich acid chlorides both electron poor (**1a**) and electron rich *N*-(prop-2-yn-1-yl)acetamide (**1b**) give rise to the isolation of **4** in comparable yields (**4d** 37%, **4f** 41%, **4k** 38%, **4m** 43%, **4p** 36%). However, if an electron deficient acid chloride is used in combination with the electron rich *N*-(prop-2-yn-1yl)acetamide (**1b**) the yields are reduced (**4e** 26%, **4i** 27%, **4t** 22%, **4y** 21%). On the other hand the electron poor *N*-(prop-2-yn-1yl)acetamide (**1a**) is not susceptible to the electronics of the remote acid chloride substituent. Apparently, this electronic interplay affects the Fischer indole step, where the hydrazone–hydrazo enamine tautomerism affects the rate of the 3,3-sigmatropic rearrangement key step. Although the overall yields of the sequence are typically found in a range of 25–46%, four new bonds are formed and two new rings are established with an average yield of 70–82% per bond forming step.

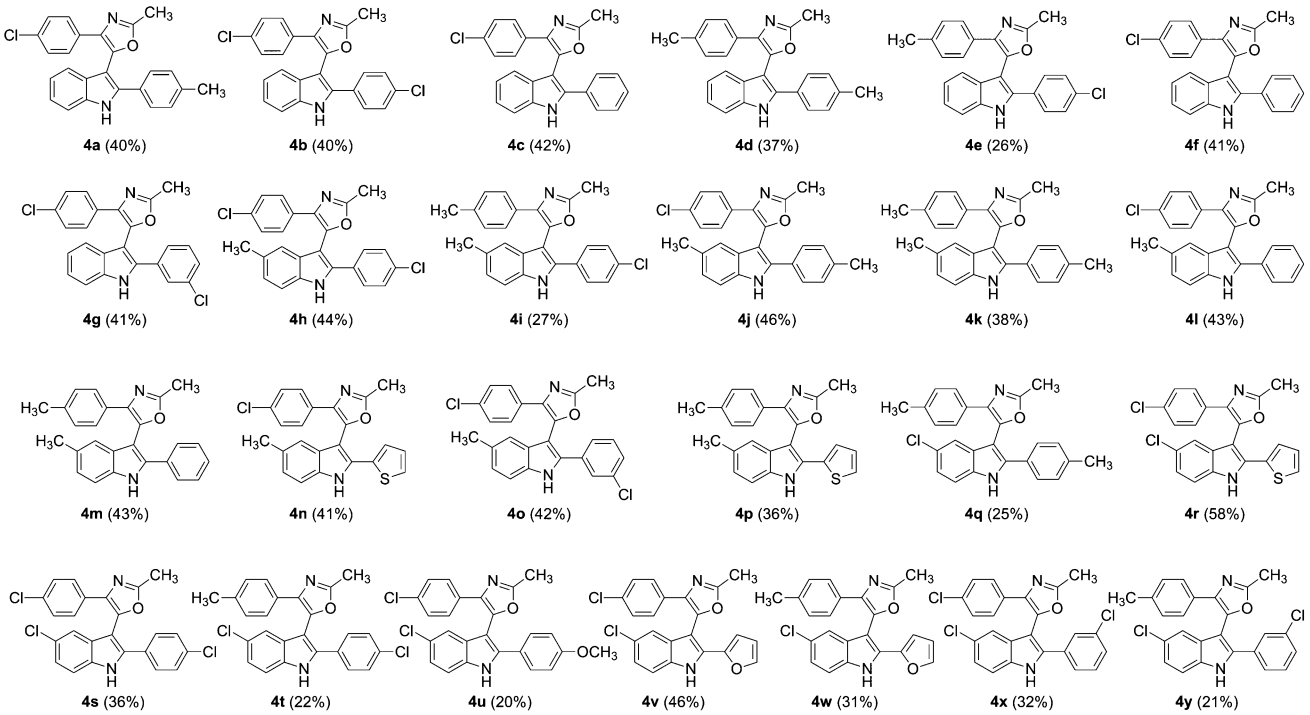


Fig. 1 5-(3-Indolyl)oxazoles **4** synthesized *via* the one-pot three-component microwave assisted coupling–cycloisomerization–Fischer indole synthesis (yields refer to isolated and purified compounds).

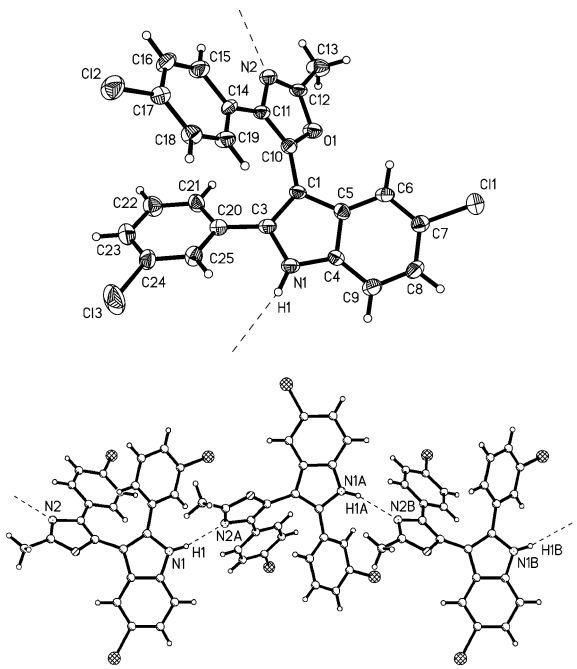


Fig. 2 Molecular structure of 5-(3-indolyl)oxazole **4x** (top) and hydrogen bonded polymeric chain in the crystal (bottom).

Table 1 Selected electronic data (UV/Vis and emission) of aryl substituted 5-(3-indolyl)oxazoles **4** (recorded in CH_2Cl_2, $T = 293$ K)

Compound	Absorption $\lambda_{max,abs}$ [nm]	Emission $\lambda_{max,em}$ [nm] (quantum yield Φ_f)[a]	Stokes shift $\Delta\tilde{\nu}$ [cm^{-1}][b]
4a	243, 299	437 (0.25)	10 600
4b	245, 300	436 (0.27)	10 400
4c	243, 298	434 (0.27)	10 500
4d	244, 299	431 (0.32)	10 200
4e	246, 314	436 (0.21)	8900
4f	241, 299	431 (0.23)	10 200
4g	244, 299	439 (0.06)	10 700
4h	247, 314	437 (0.24)	9000
4i	246, 316	439 (0.20)	8900
4j	304	434 (0.20)	9900
4k	311	437 (0.25)	9300
4l	303	435 (0.19)	10 000
4m	290, 308	437 (0.21)	9600
4n	253, 328	442 (0.08)	7900
4o	305	440 (0.11)	10 100
4p	327	442 (0.07)	8000
4q	245, 312	433 (0.26)	9000
4r	254, 328	442 (0.07)	7900
4s	245, 308	438 (0.24)	9600
4t	311	440 (0.18)	9400
4u	252, 309	430 (0.25)	9100
4v	254, 320	436 (0.20)	8300
4w	253, 321	426 (0.17)	7700
4x	306	445 (0.21)	10 200
4y	314	445 (0.19)	9400

[a] Determined with DPA (9,10-diphenyl anthracene) as a standard in cyclohexane, $\Phi_f = 0.9$. [b] $\Delta\tilde{\nu} = 1/\lambda_{max,abs} - 1/\lambda_{max,em}$ [cm^{-1}].

Electronic properties and electronic structure

The absorption and emission properties of all title compounds were studied by recording the UV/Vis and fluorescence spectra (Table 1). In the UV/Vis spectra the broad unstructured longest wavelength absorption band appears in a quite narrow range between 298 and 328 nm indicating only a modest electronic influence of the aryl substituents on the position of the maxima. However the tendency towards a slight red shift is found if the 2-indolyl substituent is heterocyclic (**4n**, **4p**, **4r**, **4v**, **4w**).

In the emission spectra, both in solution and in the solid state (film) (Fig. 3), all representatives display intense blue luminescence with emission maxima between 426 and 445 nm and enormous Stokes shifts between 7700 and 10 600 cm^{-1} (Fig. 4). With the exception of the thienyl derivatives (R^2 = 2-thienyl), the luminescence efficiency is quite substantial as indicated by the fluorescence quantum yields Φ_f in a range between 10 and 25%. As shown for compound **4x**, the emission wavelength of the solution and a film prepared by drop casting is essentially identical, however the band is significantly broader.

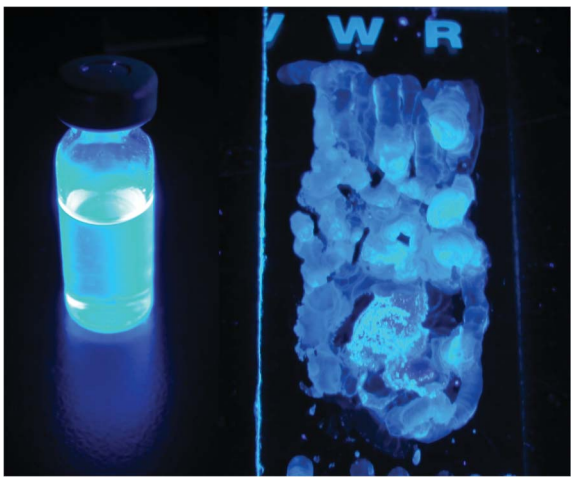


Fig. 3 Photographs of the luminescence behavior of the aryl substituted 5-(3-indolyl)oxazole **4b** in CH_2Cl_2 (left) and as a drop cast film (right) ($\lambda_{excitation}$ = 365 nm, T = 293 K).

With respect to the non-planar electronic ground state, as indicated by the X-ray structure analysis of compound **4x**, substantial planarization in the relaxed excited state by flattening causes an enhancement of the Stokes shift in comparison to simple 2,5-disubstituted oxazoles.[25]

The electronic structure of the ground state of the 5-(3-indolyl)-oxazole **4x** was studied by computations on the DFT level of theory applying the B3LYP functional[26] together with Pople's 6-311G(d,p) basis set[27] as implemented in the program Gaussian03.[28] The calculation nicely reproduces the non-planar equilibrium ground state structure as already found from the X-ray structure analysis (Fig. 2).

Furthermore, the inspection of the coefficient density in the Kohn–Sham frontier molecular orbitals indicate that the HOMO is largely and equally localized on the indole and oxazole cores including the arene bearing substituent R^1 (Fig. 5). The substituent R^2 only displays a marginal coefficient density. However in the LUMO, which reflects more or less the Franck–Condon state upon excitation, the coefficient density distribution is almost inverted, *i.e.* a minor density in the oxazole core and its aryl substituent and a major density on the aryl moiety bearing substituent R^2. The substantial residual coefficient density resides on the indole moiety, ensuring a significant overlap between the ground state and presumed excited state wavefunctions.

Based on this geometry optimized structure of compound **4x**, a ZINDO-CI calculation[29,30] reveals a strong absorption band at $\lambda_{max,calc}$ = 344 nm, which consists of a major HOMO–LUMO transition with a dominant charge transfer character from the

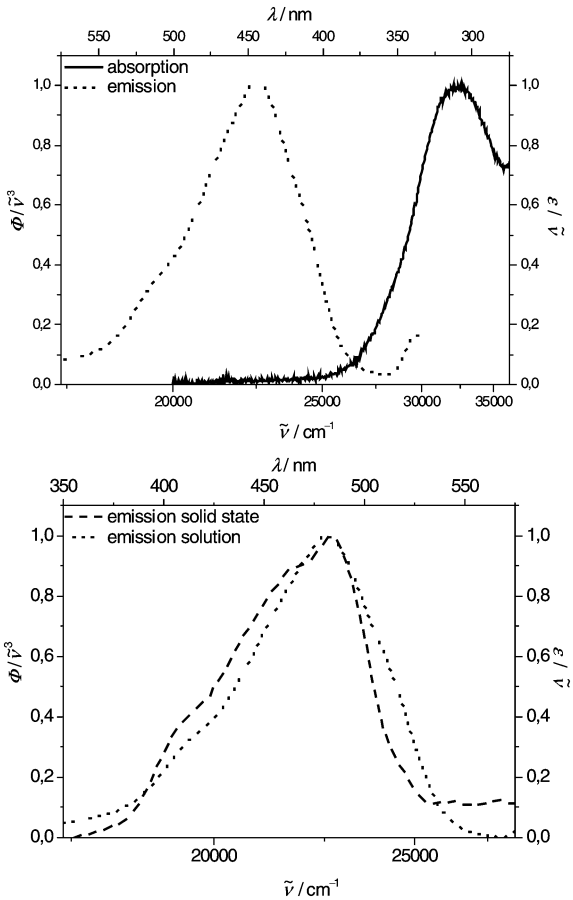


Fig. 4 Normalized (arbitrary units) absorption (solid line) and emission spectra (dotted line) in solution (top) and emission spectra in solution (dotted line) and as a drop cast film (dashed line) (bottom) of aryl substituted 5-(3-indolyl)oxazole **4x** (recorded in CH_2Cl_2, T = 293 K).

indolyl oxazole part (HOMO) to the aryl moiety R^2 (LUMO). Although the numerical data deviate from the experimental spectrum ($\lambda_{max,exp}$ = 306 nm) the electronic structure is rationalized for further optimization. Therefore, this chromophore class should lead to optimized blue-emissive chromophores on the basis of the 5-(3-indolyl)oxazole scaffold.

Conclusions

In summary, we have disclosed a novel one-pot three-component synthesis of aryl substituted 5-(3-indolyl)oxazoles consisting of a sequence of Sonogashira coupling, an acid-catalyzed cycloisomerization, and a concluding Fischer indole synthesis. All three steps are microwave assisted leading to a rapid synthesis of the title compounds, which are obtained in moderate yields. Most interestingly, all representatives turn out to be intensely blue-luminescent with large Stokes shifts upon UV-irradiation. DFT calculations reproduce the X-ray structural data and the experimental absorption spectra can be rationalized by ZINDO-CI computations. Large Stokes shift emitters are favorable for luminescent materials since significant losses of emitted light due to self-absorption and the extremely undesirable absorption of various short-lived or stable products of the radiation-induced decay are circumvented.[31] Further studies addressing the synthetic

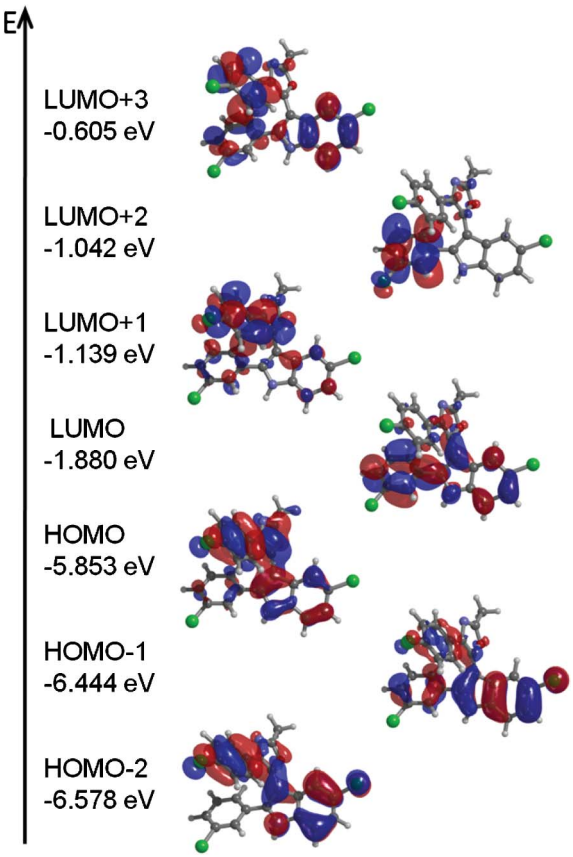


Fig. 5 Kohn–Sham frontier molecular orbitals (LUMO+3: top; HOMO–2: bottom) as computed for the aryl substituted 5-(3-indolyl)oxazole **4x** (DFT calculations with B3LYP 6-311G(d,p)).

elaboration of the sequence for tailor-made blue emitters and more detailed photophysical and computational investigations are currently underway.

Experimental

General considerations

Tetrahydrofuran was dried using *MBraun* system MB-SPS-800, and triethylamine was dried with sodium by refluxing under nitrogen, distilled and stored in a Schlenk flask over potassium hydroxide pellets under a nitrogen atmosphere. Dielectric heating was performed with Discover Labmate microwave reactor by CEM (Kamp-Lintfort, Germany). Melting points were determined on a digital melting point apparatus and temperatures and are uncorrected. ^{1}H NMR, ^{13}C NMR and 135-DEPT spectra were recorded on a Bruker Avance DRX500 spectrometer. $CDCl_3$ and DMSO-d_6 were used as deuterated solvents. The solvents were locked as internal standards ($CDCl_3$: ^{1}H δ 7.26, ^{13}C δ 77.16; DMSO-d_6: ^{1}H δ 2.50, ^{13}C δ 39.52). The multiplicities of signals were abbreviated as follows: s: singlet; d: doublet; t: triplet; dd: doublet of doublets; ddd: doublet of doublets of doublets; dt: doublet of triplets; td: triplet of doublets; tt: triplet of triplets; m: multiplet and br: broad signal. The type of carbon atoms were determined on the basis of 135-DEPT NMR spectra. Infrared spectra were recorded on a Vector 22 spectrophotometer (Bruker). The intensity of signals is abbreviated as follows: s (strong), m (medium) and w (weak). Flash column chromatography was performed on 60 M (mesh 230-400) silica gel (Merck or Macherey–Nagel). For thin-layer chromatography (TLC), silica gel plates (Merck; 60 F_{154}) were used. The spots were detected with UV light at 254 nm and using aqueous potassium permanganate solution. Combustion analysis was performed on a Perkin Elmer CHN-Analyzer 2400. Mass spectra were recorded by MALDI (Bruker Ultraflex). The UV/Vis Spectra were recorded on a Perkin Elmer Models Lambda 19 and the Emission spectra were recorded on a Perkin Elmer LS55 spectrometer.

General procedure of the microwave-assisted three-component coupling–cycloisomerization–Fischer indole synthesis of 5-(3-indolyl)oxazoles 4

A microwave reaction vessel was loaded with dry THF (3 mL) and flushed with nitrogen by a cannula. Then, the *N*-(prop-2-yn-1-yl)acetamide **1** (0.5 mmol), the (hetero)aroyl chloride **2** (0.5 mmol), $PdCl_2(PPh_3)_2$ (7 mg, 2 mol%), CuI (4 mg, 4 mol%), and NEt_3 (0.07 ml) were successively added and dissolved in THF. The reaction mixture was heated in the microwave cavity at 120 °C for a hold time of 15 min. After cooling to room temp *t*-BuOH (1 mL) and PTSA·H_2O (192 mg, 1.00 mmol) were added to the reaction mixture and heating in the microwave cavity at 80 °C for a hold time of 1 h was continued. Then, arylhydrazine **3** (1 mmol) and PTSA·H_2O (192 mg, 1.00 mmol) were added to the reaction mixture and heating in the microwave cavity at 150 °C for a hold time of 15 min was continued. After cooling to room temperature the solvents were removed *in vacuo* and the residue was chromatographed on silica gel (hexanes/ethylacetate 20 : 1) to afford the analytically pure 5-(3-indolyl)oxazoles **4** (For experimental details see Table 2).

4-(4-Chlorophenyl)-2-methyl-5-(2-*p*-tolyl-1*H*-indol-3-yl)oxazole (4a)

Yellow solid, Mp. 226 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ 2.33 (s, 3 H), 2.52 (s, 3 H), 7.09–7.11 (m, 5 H), 7.26 (m, 1 H), 7.31 (m, 3 H), 7.45 (d, ^3J = 8.1 Hz, 1 H), 7.49 (d, ^3J = 8.7 Hz, 2 H), 8.54 (s, 1 H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 14.3 (CH_3), 21.4 (CH_3), 101.3 (C_{quat}), 111.2 (CH), 120.1 (CH), 121.2 (CH), 123.3 (CH), 127.1 (CH), 127.6 (CH), 128.5 (C_{quat}), 128.5 (CH), 128.8 (C_{quat}), 129.8 (CH), 130.7 (C_{quat}), 132.9 (C_{quat}), 135.6 (C_{quat}), 135.8 (C_{quat}), 137.7 (C_{quat}), 138.8 (C_{quat}), 140.8 (C_{quat}), 161.1 (C_{quat}). MS (MALDI-TOF): m/z = 399.0. UV/Vis (EtOH): λ_{max} (ε) = 243 nm (4100), 299 (7300). IR (KBr): $\tilde{\nu}$ [cm^{-1}] = 3431 (w), 3172 (w), 1628 (w), 1586(m), 1561 (w), 1495 (w), 1480 (w), 1442 (m), 1406 (m), 1382 (w), 1341 (w), 1292 (m), 1236 (w), 1190 (m), 1137 (w), 1090 (m), 1027 (m), 1023 (w), 1004 (m), 969 (w), 939 (m), 827 (m), 766 (w), 742 (s), 718 (m), 679 (w), 625 (w), 601 (w), 514 (w). Anal. calcd. for $C_{25}H_{19}ClN_2O$ (398.9): C 75.28, H 4.80, N 7.02; Found: C 75.08, H 4.79, N 6.97%.

4-(4-Chlorophenyl)-5-(2-(4-chlorophenyl)-1*H*-indol-3-yl)-2-methyloxazole (4b)

Yellow solid, Mp. 221 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ 2.53 (s, 3 H), 7.11 (d, ^3J = 8.6 Hz, 2 H), 7.15 (m, 1 H) 7.26–7.29 (m, 3 H), 7.33–7.36 (m, 3 H), 7.45–7.48 (m, 3 H), 8.66 (s, 1 H). ^{13}C

Table 2 Experimental details of the microwave-assisted three-component coupling–cycloisomerization–Fischer indole synthesis of 5-(3-indolyl)oxazoles **4**

Entry	*N*-(Prop-2-yn-1-yl)-acetamide **1** [mg] (mmol)	(Hetero)aroyl chloride **2** [mg] (mmol)	Arylhydrazine **3** [mg] (mmol)[a]	5-(3-Indolyl)-oxazoles **4** [mg] (yield,%)
1	103 (0.50) of **1a**	78 (0.50) of **2a**	144 (1.00) of **3a**	79 (40) of **4a**
2	103 (0.50) of **1a**	88 (0.50) of **2b**	144 (1.00) of **3a**	84 (40) of **4b**
3	103 (0.50) of **1a**	70 (0.50) of **2c**	144 (1.00) of **3a**	81 (42) of **4c**
4	93 (0.50) of **1b**	78 (0.50) of **2a**	144 (1.00) of **3a**	70 (37) of **4d**
5	93 (0.50) of **1b**	88 (0.50) of **2b**	144 (1.00) of **3a**	51 (26) of **4e**
6	93 (0.50) of **1b**	70 (0.50) of **2c**	144 (1.00) of **3a**	75 (41) of **4f**
7	103 (0.50) of **1a**	88 (0.50) of **2d**	144 (1.00) of **3a**	86 (41) of **4g**
8	103 (0.50) of **1a**	88 (0.50) of **2b**	158 (1.00) of **3b**	95 (44) of **4h**
9	93 (0.50) of **1b**	88 (0.50) of **2b**	158 (1.00) of **3b**	55 (27) of **4i**
10	103 (0.50) of **1a**	78 (0.50) of **2a**	158 (1.00) of **3b**	96 (47) of **4j**
11	93 (0.50) of **1b**	78 (0.50) of **2a**	158 (1.00) of **3b**	74 (38) of **4k**
12	103 (0.50) of **1a**	70 (0.50) of **2c**	158 (1.00) of **3b**	85 (43) of **4l**
13	93 (0.50) of **1b**	70 (0.50) of **2c**	158 (1.00) of **3b**	81 (43) of **4m**
14	103 (0.50) of **1a**	73 (0.50) of **2e**	158 (1.00) of **3b**	82 (41) of **4n**
15	103 (0.50) of **1a**	88 (0.50) of **2d**	158 (1.00) of **3b**	91 (42) of **4o**
16	93 (0.50) of **1b**	73 (0.50) of **2e**	158 (1.00) of **3b**	69 (36) of **4p**
17	93 (0.50) of **1b**	78 (0.50) of **2a**	179 (1.00) of **3c**	52 (25) of **4q**
18	103 (0.50) of **1a**	73 (0.50) of **2e**	179 (1.00) of **3c**	123 (58) of **4r**
19	103 (0.50) of **1a**	88 (0.50) of **2b**	179 (1.00) of **3c**	81 (36) of **4s**
20	93 (0.50) of **1b**	88 (0.50) of **2b**	179 (1.00) of **3c**	48 (22) of **4t**
21	103 (0.50) of **1a**	85 (0.50) of **2f**	179 (1.00) of **3c**	45 (20) of **4u**
22	103 (0.50) of **1a**	65 (0.50) of **2g**	179 (1.00) of **3c**	93 (46) of **4v**
23	93 (0.50) of **1b**	65 (0.50) of **2g**	179 (1.00) of **3c**	62 (31) of **4w**
24	103 (0.50) of **1a**	88 (0.50) of **2d**	179 (1.00) of **3c**	71 (32) of **4x**
25	93 (0.50) of **1b**	88 (0.50) of **2d**	179 (1.00) of **3c**	45 (21) of **4y**

[a] Applied as the hydrochloride.

NMR (125 MHz, $CDCl_3$): δ 14.3 (CH_3), 102.2 (C_{quat}), 111.4 (CH), 115.3 (C_{quat}), 120.3 (CH), 121.5 (CH), 123.7 (CH), 127.7 (CH), 128.1 (C_{quat}), 128.5 (CH), 128.6 (CH), 129.4 (CH), 130.2 (C_{quat}), 130.5 (C_{quat}), 133.1 (C_{quat}), 134.6 (C_{quat}), 135.8 (C_{quat}), 136.0 (C_{quat}), 136.2 (C_{quat}), 140.3 (C_{quat}), 161.3 (C_{quat}). MS (MALDI-TOF): m/z = 418.9. UV/Vis (EtOH): λ_{max} (ε) [nm] = 245 (5100), 300 (11200). IR (KBr): $\tilde{\nu}$ [cm^{-1}] = 3412 (s), 1637 (w), 1584 (w), 1534 (w), 1499 (w), 1478 (m), 1454 (m), 1406 (w), 1377 (w), 1325 (w), 1292 (w), 1265 (w), 1187 (w), 1094 (s), 1014 (m), 1001 (m), 959 (w), 938 (w), 840 (m), 828 (m), 738 (m), 703 (w), 557 (w), 512 (w). Anal. calcd. for $C_{24}H_{16}Cl_2N_2O$ (419.3): C 68.75, H 3.85, N 6.68; Found: C 68.53, H 3.76, N 6.47%.

4-(4-Chlorophenyl)-2-methyl-5-(2-phenyl-1*H*-indol-3-yl)oxazole (4c)

Yellow solid, Mp. 210 °C. ^{1}H NMR (500 MHz, DMSO-d_6): δ 2.49 (s, 3 H), 7.03 (d, ^3J = 7.3 Hz, 1 H), 7.13–7.26 (m, 4 H), 7.31 (d, ^3J = 7.1, 1 H), 7.37 (t, ^3J = 7.4 Hz, 2 H), 7.48 (d, ^3J = 8.6 Hz, 2 H), 7.53 (m, 3H), 12.06 (s, 1 H). ^{13}C NMR (75 MHz, DMSO-d_6): δ 13.7 (CH_3), 99.6 (C_{quat}), 112.0 (CH), 118.9 (CH), 120.4 (CH), 122.6 (CH), 126.9 (CH), 127.1 (CH) 127.6 (C_{quat}), 128.3 (CH), 128.4 (CH), 128.8 (CH), 130.7 (C_{quat}), 131.4 (C_{quat}), 131.6 (C_{quat}), 134.3 (C_{quat}), 136.2 (C_{quat}), 137.4 (C_{quat}), 140.6 (C_{quat}), 160.8 (C_{quat}). MS (MALDI-TOF): m/z = 384.9. UV/Vis (EtOH): λ_{max} (ε) [nm] = 243 (6900), 298 (8800). IR (KBr): $\tilde{\nu}$ [cm^{-1}] = 3422 (m), 3185 (m), 1583 (m), 1496 (m), 1456 (m), 1293 (m), 1236 (s), 1189 (s), 1139 (s), 1092 (m), 1009 (m), 970 (s), 941 (s), 833 (m), 745 (m), 698 (m), 636 (s), 611 (s). Anal. calcd. for $C_{24}H_{17}ClN_2O$ (384.9): C 74.90, H 4.45, N 7.28; Found: C 74.66, H 4.62, N 7.09%.

2-Methyl-4-*p*-tolyl-5-(2-p-tolyl-1*H*-indol-3-yl)oxazole (4d)

Yellow solid, Mp. 204 °C. ^{1}H NMR (500 MHz, DMSO-d_6): δ 2.18 (s, 3 H) 2.28 (s, 3 H), 2.46 (s, 3 H), 7.00–6.96 (m, 3 H), 7.08 (d, ^3J = 7.9 Hz, 1 H), 7.16 (d, ^3J = 8.1 Hz, 1 H), 7.19 (d, ^3J = 8.0 Hz, 2 H), 7.39 (d, ^3J = 7.9 Hz, 2 H), 7.44 (d, ^3J = 7.9 Hz, 2 H), 7.49 (d, ^3J = 8.1 Hz, 1 H), 11.94 (s, 1 H). ^{13}C NMR (75 MHz, DMSO-d_6): δ 13.7 (CH_3), 20.7 (CH_3), 20.8 (CH_3), 99.7 (C_{quat}), 111.8 (CH), 118.7 (CH), 120.2 (CH), 122.3 (CH), 125.4 (CH), 126.7 (CH), 127.9 (C_{quat}), 128.7 (CH), 128.9 (CH), 129.0 (C_{quat}), 129.4 (CH), 135.6 (C_{quat}), 136.0 (C_{quat}), 136.3 (C_{quat}), 137.4 (C_{quat}), 137.7 (C_{quat}), 139.5 (C_{quat}), 160.4 (C_{quat}). MS (MALDI-TOF): m/z = 379.0. UV/Vis (EtOH): λ_{max} (ε) [nm] = 244 (2200), 299 (4200). IR (KBr): $\tilde{\nu}$ [cm^{-1}] = 3413 (s), 3022 (s), 2923 (s), 1910 (s), 1635 (s), 1598 (m), 1543 (s), 1519 (s), 1492 (s), 1454 (m), 1377 (s), 1349 (s), 1328 (s), 1267 (m), 1180 (s), 1133 (s), 1094 (s), 1000 (m), 959 (s), 937 (s), 823 (m), 810 (m), 739 (s), 729 (m), 675 (s), 629 (s), 586 (s), 555 (s), 511 (s). Anal. calcd. for $C_{26}H_{22}N_2O$ (378.5): C 82.51, H 5.86, N 7.40; Found: C 82.34, H 5.93, N 7.32%.

5-(2-(4-Chlorophenyl)-1*H*-indol-3-yl)-2-methyl-4-*p*-tolyloxazole (4e)

Yellow solid, Mp. 245 °C. ^{1}H NMR (500 MHz, DMSO-d_6): δ 2.18 (s, 3 H), 2.47 (s, 3 H), 6.98 (d, ^3J = 8.4 Hz, 2 H), 7.01 (d, ^3J = 7.1 Hz, 1 H), 7.13 (d, ^3J = 7.9 Hz, 1 H), 7.20 (t, ^3J = 7.6 Hz, 1 H), 7.37 (d, ^3J = 8.1 Hz, 2 H), 7.45 (d, ^3J = 8.6 Hz, 2 H), 7.52 (t, ^3J = 8.8 Hz, 3 H), 12.07 (s, 1 H). ^{13}C NMR (75 MHz, DMSO-d_6): δ 13.7 (CH_3), 20.7 (CH_3), 100.7 (C_{quat}), 111.9 (CH), 119.1 (CH), 120.4 (CH), 122.8 (CH), 125.4 (CH), 127.6 (C_{quat}), 128.5 (CH), 128.9 (CH), 128.9 (CH), 130.4 (C_{quat}), 132.8 (C_{quat}), 135.6 (C_{quat}),

135.8 (C_{quat}), 136.2 (C_{quat}), 136.4 (C_{quat}), 139.1 (C_{quat}), 160.6 (C_{quat}). MS (MALDI-TOF): m/z = 399.0. UV/Vis (EtOH): λ_{max} (ε) [nm] = 246 (4900), 314 (7000). IR (KBr): $\tilde{\nu}$ [cm^{-1}] = 3411(s), 1636 (w), 1597 (w), 1515 (w), 1483 (w), 1454 (w), 1378 (w), 1327 (w), 1267 (w), 1181 (w), 1100 (m), 1015 (w), 1000 (w), 960 (w), 937 (w), 822 (m), 737 (m), 729 (m), 585 (w), 555 (w), 512 (w). Anal. calcd. for $C_{25}H_{19}ClN_2O$ (398.9): C 75.28, H 4.80, N 7.02; Found: C 75.01, H 4.77, N 6.90%.

2-Methyl-5-(2-phenyl-1*H*-indol-3-yl)-4-*p*-tolyloxazole (4f)

Yellow solid, Mp. 200 °C. ^{1}H NMR (500 MHz, DMSO-d_6): δ 2.18 (s, 3 H), 2.47 (s, 3 H), 6.99 (dd, ^3J = 8.0 Hz, ^4J = 11.0 Hz, 3 H), 7.10 (d, ^3J = 7.9 Hz, 1 H), 7.54 (d, ^3J = 7.5 Hz, 2 H), 7.19 (t, ^3J = 7.6 Hz, 1 H), 7.30 (t, ^3J = 7.3 Hz, 1 H), 7.38 (t, ^3J = 8.6 Hz, 4 H), 7.51 (d, ^3J = 8.1 Hz, 1 H), 12.01 (s, 1 H). ^{13}C NMR (75 MHz, DMSO-d_6): δ 13.7 (CH_3), 20.7 (CH_3), 100.2 (C_{quat}), 111.9 (CH), 118.9 (CH), 120.2 (CH), 122.5 (CH), 125.4 (CH), 126.8 (CH), 127.8 (C_{quat}), 128.2 (CH), 128.8 (CH), 128.9 (CH), 129.0 (C_{quat}), 131.5 (C_{quat}), 135.6 (C_{quat}), 136.1 (C_{quat}), 136.4 (C_{quat}), 137.2 (C_{quat}), 139.4 (C_{quat}), 160.5 (C_{quat}). MS (MALDI-TOF): m/z = 365.0. UV/Vis (EtOH): λ_{max} (ε) [nm] = 241 (4300), 299 (8100). IR (KBr): $\tilde{\nu}$ [cm^{-1}] = 3406 (s), 1638 (w), 1595 (m), 1515 (w), 1486 (w), 1452 (m), 1379 (w), 1267 (m), 1186 (w), 1096 (w), 999 (m), 957 (w), 938 (w), 822 (w), 739 (m), 689 (w), 588 (w), 567 (w), 511 (w). Anal. calcd. for $C_{25}H_{20}N_2O$ (384.9): C 82.39, H 5.53, N 7.69; Found: C 82.17, H 5.48, N 7.54%.

4-(4-Chlorophenyl)-5-(2-(3-chlorophenyl)-1*H*-indol-3-yl)-2-methyloxazole (4g)

Yellow solid, Mp. 188 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ 2.54 (s, 3 H), 7. 09 (d, ^3J = 8.6 Hz, 2 H), 7.15 (d, ^3J = 7.5 Hz, 1 H), 7.21 (d, ^3J = 7.4 Hz, 1 H), 7.24 (ddd, ^3J = 7.9 Hz, ^4J = 3.9 Hz, ^5J = 1.8 Hz, 2 H), 7.3 (dd, ^3J = 7.6, 6.7, 1 H), 7.38 (d, ^3J = 7.9 Hz, 1 H), 7.41 (d, ^3J = 1.8 Hz, 1 H), 7.44 (d, ^3J = 8.6, 2H), 7.47 (d, ^3J = 8.2 Hz, 1 H), 8.59 (s, 1 H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 14.3 (CH_3), 102.6 (C_{quat}), 111.4 (CH), 120.5 (CH), 121.5 (CH), 123.9 (CH), 125.3 (CH), 127.3 (CH), 127.8 (CH), 128.0 (C_{quat}), 128.5 (CH), 128.6 (CH), 130.3 (CH), 130.5 (C_{quat}), 133.1 (C_{quat}), 133.5 (C_{quat}), 135.0 (C_{quat}), 135.8 (C_{quat}), 135.8 (C_{quat}), 136.1 (C_{quat}), 140.2 (C_{quat}), 161.3 (C_{quat}). MS (MALDI-TOF): m/z = 418.9 (^{35}Cl-M^+), 419.9, 420.9 (^{37}Cl-M^+). UV/Vis (EtOH): λ_{max} (ε) [nm] = 244 (13300), 299 (15000). IR (KBr): $\tilde{\nu}$ [cm^{-1}] = 3422 (m), 3141 (m), 2346 (w), 1584 (m), 1497 (w), 1449 (m), 1406 (w), 1340 (w), 1290 (m), 1236 (w), 1189 (w), 1135 (w), 1094 (s), 1004 (m), 969 (w), 944 (w), 914 (w), 898 (w), 829 (w), 791 (w), 741 (s), 688 (m), 632 (w), 528 (w). Anal. calcd. for $C_{24}H_{16}Cl_2N_2O$ (419.3): C 68.75, H 3.85, N 6.68; Found: C 68.55, H 3.87, N 6.70%.

4-(4-Chlorophenyl)-5-(2-(4-chlorophenyl)-5-methyl-1*H*-indol-3-yl)-2-methyloxazole (4h)

Yellow solid, Mp. 222 °C. ^{1}H NMR (500 MHz, DMSO-d_6): δ 2.29 (s, 3 H), 2.50 (s, 3 H), 6.98 (s, 1 H), 7.04 (d, ^3J = 8.3 Hz, 1 H), 7.24 (d, ^3J = 8.6 Hz, 2 H), 7.39 (s, 1 H), 7.42 (d, ^3J = 8.7 Hz, 2 H), 7.44 (d, ^3J = 8.6 Hz, 2 H), 7.48 (d, ^3J = 8.6 Hz, 2 H), 11.98 (s, 1 H). ^{13}C NMR (75 MHz, DMSO-d_6): δ 13.7 (CH_3), 21.2 (CH_3), 99.6 (C_{quat}), 111.7 (CH) 118.4 (CH), 124.6 (CH), 127.1 (CH), 127.9 (C_{quat}) 128.4 (CH), 128.5 (CH), 128.9 (CH), 129.3 (C_{quat}), 130.4 (C_{quat}), 130.6 (C_{quat}), 131.6 (C_{quat}), 132.8 (C_{quat}), 134.3 (C_{quat}), 134.6 (C_{quat}), 136.0 (C_{quat}), 140.5 (C_{quat}), 160.9 (C_{quat}). MS (MALDI-TOF): m/z = 433.0. UV/Vis (EtOH): λ_{max} (ε) [nm] = 247 (4100) 314 (5600). IR (KBr): $\tilde{\nu}$ [cm^{-1}] = 3417 (s), 1719 (w), 1628 (w), 1595 (w), 1528 (w), 1499 (w), 1476 (w), 1449 (w), 1407 (w), 1376 (w), 1264 (w), 1209 (w), 1091(m), 1015 (w), 996 (w), 963 (w), 932 (w), 865 (w), 837 (m), 821 (m), 793 (m), 726 (w), 699 (w), 597 (w), 552 (w), 510 (w). Anal. calcd. for $C_{25}H_{18}Cl_2N_2O$ (433.3): C 69.29, H 4.19, N 6.46; Found: C 69.34, H 4.28, N 6.29%.

5-(2-(4-Chlorophenyl)-5-methyl-1*H*-indol-3-yl)-2-methyl-4-*p*-tolyloxazole (4i)

Yellow solid, Mp. 246 °C. ^{1}H NMR (500 MHz, DMSO-d_6): δ 2.18 (s, 3 H), 2.28 (s, 3 H), 2.48 (s, 3 H), 6.94 (s, 1 H), 6.98 (d, ^3J = 8.1 Hz, 2 H), 7.03 (dd, ^3J = 8.4 Hz, ^4J = 1.3 Hz, 1 H), 7.36 (d, ^3J = 8.2 Hz, 2 H), 7.40 (d, ^3J = 8.3 Hz, 1 H), 7.43 (d, ^3J = 8.7 Hz, 2 H), 7.51–7.48 (m, 2 H), 11.94 (s, 1 H). ^{13}C NMR (75 MHz, DMSO-d_6): δ 13.8 (CH_3), 20.7 (CH_3), 21.1 (CH_3), 100.2 (C_{quat}), 111.7 (CH), 118.4 (CH), 124.5 (CH), 125.3 (CH), 128.2 (C_{quat}), 128.3 (CH), 128.9 (CH), 128.9 (CH), 129.1 (C_{quat}), 130.5 (C_{quat}), 132.7 (C_{quat}), 134.5 (C_{quat}), 135.6 (C_{quat}), 135.8 (C_{quat}), 136.4 (C_{quat}), 139.3 (C_{quat}), 160.6 (C_{quat}). MS (MALDI-TOF): m/z = 413.0. UV/Vis (EtOH): λ_{max} (ε) [nm] = 246 (4800), 316 (7600). IR (KBr): $\tilde{\nu}$ [cm^{-1}] = 3415 (s), 2921 (w), 1736 (w), 1629 (w), 1596 (m), 1535 (w), 1513 (w), 1479 (m), 1450 (m), 1376 (w), 1311 (w), 1266 (m), 1208 (w), 1181 (w), 1098 (m), 1042 (w), 1014 (w), 996 (w), 963 (w), 933 (w), 862 (w), 839 (w), 823 (s), 789 (m), 727 (w), 590 (w), 551 (w), 511 (w). Anal. calcd. for $C_{26}H_{21}ClN_2O$ (412.9): C 75.63, H 5.13, N 6.78; Found: C 75.50, H 5.26, N 6.57%.

4-(4-Chlorophenyl)-2-methyl-5-(5-methyl-2-*p*-tolyl-1*H*-indol-3-yl)oxazole (4j)

Yellow solid, Mp. 238 °C. ^{1}H NMR (500 MHz, DMSO-d_6): δ 2.26 (s, 3 H), 2.28 (s, 3 H), 2.49 (s, 3 H), 6.93 (s, 1 H), 7.01 (d, ^3J = 8.3 Hz, 1 H), 7.15–7.17 (m, 2 H), 7.4 (d, ^3J = 8.6 Hz, 2 H), 7.38 (d, ^3J = 8.2 Hz, 3 H), 7.47 (d, ^3J = 8.7 Hz, 2 H), 11.85 (s, 1 H). ^{13}C NMR (75 MHz, DMSO-d_6): δ 13.7 (CH_3), 20.7 (CH_3), 21.2 (CH_3), 98.7 (C_{quat}), 111.6 (CH), 118.1 (CH), 124.1 (CH), 126.6 (CH), 127.0 (CH), 128.2 (C_{quat}), 128.4 (CH), 128.7 (C_{quat}), 129.0 (C_{quat}), 129.4 (CH), 130.7 (C_{quat}), 131.6 (C_{quat}), 134.3 (C_{quat}), 134.4 (C_{quat}), 137.6 (C_{quat}), 137.7 (C_{quat}), 140.9 (C_{quat}), 160.7 (C_{quat}). MS (MALDI-TOF): m/z = 412.0. UV/Vis (EtOH): λ_{max} (ε) [nm] = 304 (20900). IR (KBr): $\tilde{\nu}$ [cm^{-1}] = 3442 (m), 3147 (m), 1639 (w), 1587 (m), 1561 (w), 1543 (w), 1503 (w), 1487 (w), 1450 (m), 1406 (w), 1382 (w), 1316 (w), 1292 (m), 1236 (w), 1206 (w), 1155 (w), 1093 (s), 1038 (w), 1010 (w), 996 (w), 969 (w), 950 (w), 936 (w), 828 (s), 794 (s), 742 (w), 716 (m), 680 (w), 648 (w), 611 (m), 578 (w), 517 (m). Anal. calcd. for $C_{26}H_{21}ClN_2O$ (412.9): C 75.63, H 5.13, N 6.78; Found: C 75.41, H 5.16, N 6.57%.

2-Methyl-5-(5-methyl-2-*p*-tolyl-1*H*-indol-3-yl)-4-*p*-tolyloxazole (4k)

Yellow solid, Mp. 213 °C. ^{1}H NMR (500 MHz, DMSO-d_6): δ 2.18 (s, 3 H), 2.26 (d, ^3J = 2.6 Hz, 6 H), 2.47 (s, 3 H), 6.89 (s, 1 H), 6.99 (m, 3 H), 7.16 (d, ^3J = 8.2 Hz, 2 H), 7.42–7.36 (m, 5 H), 11.81 (s, 1 H). ^{13}C NMR (125 MHz, DMSO-d_6): δ 13.7 (CH_3), 20.7 (CH_3), 20.7 (CH_3), 21.2 (CH_3), 99.2 (C_{quat}), 111.5 (CH), 118.2 (CH), 124.0 (CH), 125.3 (CH), 126.5 (CH), 128.5 (C_{quat}), 128.8 (C_{quat}), 128.9

(C_{quat}), 128.9 (CH), 129.0 (C_{quat}), 129.4 (CH), 134.3 (CH_{quat}), 135.6 (C_{quat}), 136.3 (C_{quat}), 137.5 (C_{quat}), 137.6 (C_{quat}), 139.7 (C_{quat}), 160.4 (C_{quat}). MS (MALDI-TOF): m/z = 392.0. UV/Vis (EtOH): λ_{max} (ε) [nm] = 311 (22500). IR (KBr): $\tilde{\nu}$ [cm^{-1}] = 3201 (s), 3018 (w), 2918 (w), 1870 (w), 1719 (w), 1686 (w), 1655 (w), 1637 (w), 1585 (s), 1544 (w), 1518 (w), 1484 (w), 1450 (s), 1375 (m), 1322 (w), 1287 (s), 1202 (w), 1184 (w), 1151 (w), 1133 (w), 1088 (w), 992 (w), 966 (w), 937 (m), 865 (w), 822 (s), 800 (s), 733 (w), 720 (w), 648 (w), 608 (w), 576 (w), 560 (w), 516 (w). Anal. calcd. for $C_{27}H_{24}N_2O$ (392.5): C 82.62, H 6.16, N 7.14; Found: C 82.33, H 6.22, N 7.02%.

4-(4-Chlorophenyl)-2-methyl-5-(5-methyl-2-phenyl-1*H*-indol-3-yl)oxazole (4l)

Yellow solid, Mp. 200 °C. ^{1}H NMR (500 MHz, DMSO-d_6): δ 2.29 (s, 3 H), 2.50 (s, 3 H), 6.96 (s, 1 H), 7.03 (d, ^3J = 8.3 Hz, 1 H), 7.25–7.22 (m, 2 H), 7.28 (d, ^3J = 7.4 Hz, 1 H), 7.35 (t, ^3J = 7.6 Hz, 2 H), 7.41 (d, ^3J = 8.3 Hz, 1 H), 7.48–7.45 (m, 2 H), 7.50–7.48 (m, 2 H), 11.92 (s, 1 H). ^{13}C NMR (125 MHz, DMSO-d_6): δ 13.7 (CH_3), 21.5 (CH_3), 99.1 (C_{quat}), 111.7 (CH), 118.3 (CH), 124.3 (CH), 126.8 (CH), 127.0 (CH), 128.1 (C_{quat}), 128.1 (C_{quat}), 128.4 (CH), 128.8 (CH), 129.1 (C_{quat}), 130.7 (C_{quat}), 131.5 (C_{quat}), 131.6 (C_{quat}), 134.3 (CH_{quat}), 134.5 (C_{quat}), 137.4 (C_{quat}), 140.8 (C_{quat}), 160.8 (C_{quat}). MS (MALDI-TOF): m/z = 399.0. UV/Vis (EtOH): λ_{max} (ε) [nm] = 303 (8300). IR (KBr): $\tilde{\nu}$ [cm^{-1}] = 3449 (s), 3187 (s), 1736 (w), 1719 (w), 1701 (w), 1686 (m), 1655 (w), 1638 (w), 1578 (w), 1561 (m), 1544 (w), 1497 (m), 1478 (m), 1458 (m), 1440 (m), 1401 (m), 1379 (w), 1313 (w), 1294 (s), 1212, 1157 (w), 1136 (w), 1090 (s), 1030 (w), 1010 (m), 969 (w), 938 (w), 866 (w), 831 (s), 802 (s), 766 (m), 742 (w), 698 (s), 625 (w), 557 (w). Anal. calcd. for $C_{25}H_{19}ClN_2O$ (398.9): C 75.28, H 4.80, N 7.02; Found: C 75.11, H 4.88, N 6.93%.

2-Methyl-5-(5-methyl-2-phenyl-1*H*-indol-3-yl)-4-*p*-tolyloxazole (4m)

Yellow solid, Mp. 194 °C. ^{1}H NMR (500 MHz, DMSO-d_6): δ 2.18 (s, 3 H), 2.28 (s, 3 H), 2.48 (s, 3 H), 6.92 (s, 1 H), 6.98 (d, ^3J = 8.0 Hz, 2 H), 7.02 (d, ^3J = 8.1 Hz, 1 H), 7.28 (t, ^3J = 7.3 Hz, 1 H), 7.41–7.34 (m, 5 H), 7.51 (d, ^3J = 7.9 Hz, 2 H), 11.87 (s, 1 H). ^{13}C NMR (125 MHz, DMSO-d_6): δ 13.7 (CH_3), 20.7 (CH_3), 21.2 (CH_3), 99.7 (C_{quat}), 111.6 (CH), 118.3 (CH), 124.2 (CH), 125.3 (CH), 126.6 (CH), 128.0 (CH), 128.4 (C_{quat}), 128.8 (CH), 128.9 (CH), 129.0 (C_{quat}), 129.0 (C_{quat}), 131.6 (C_{quat}), 134.4 (C_{quat}), 135.7 (C_{quat}), 136.4 (C_{quat}), 137.3 (C_{quat}), 139.6 (C_{quat}), 160.5 (C_{quat}). MS (MALDI-TOF): m/z = 378.0. UV/Vis (EtOH): λ_{max} (ε) [nm] = 290 (14000), 308 (14600). IR (KBr): $\tilde{\nu}$ [cm^{-1}] = 3412 (s), 3180 (s), 3025 (m), 2917 (m), 2346 (w), 1775 (w), 1655 (w), 1638 (w), 1583 (s), 1561 (w), 1543 (w), 1510 (m), 1479 (w), 1460 (s), 1381 (m), 1308 (m), 1289 (s), 1204 (w), 1185 (w), 1153 (w), 1132 (w), 1092 (m), 1031 (w), 995 (m), 968 (w), 937 (w), 916 (w), 865 (w), 825 (m), 799 (m), 768 (m), 731, 696 (s), 625 (w), 594 (w), 558 (w), 517 (w). Anal. calcd. for $C_{26}H_{22}N_2O$ (378.5): C 82.51, H 5.86, N 7.40; Found: C 82.53, H 6.15, N 7.31%.

4-(4-Chlorophenyl)-2-methyl-5-(5-methyl-2-(thiophen-2-yl)-1*H*-indol-3-yl)oxazole (4n)

Brown solid, Mp. 226 °C. ^{1}H NMR (500 MHz, DMSO-d_6): δ 2.29 (s, 3 H), 2.52 (s, 3 H), 6.96 (s, 1 H), 7.04 (d, ^3J = 8.2 Hz, 1 H), 7.09–7.06 (m, 1 H), 7.28 (d, ^3J = 8.6 Hz, 2 H), 7.38 (d, ^3J = 8.2 Hz, 1 H), 7.47–7.51 (m, 4 H), 11.98 (s, 1 H). ^{13}C NMR (125 MHz, DMSO-d_6): δ 13.8 (CH_3), 21.1 (CH_3), 98.8 (C_{quat}), 111.4 (CH), 118.0 (CH), 124.6 (CH), 125.4 (CH), 126.9 (CH), 127.5 (C_{quat}), 127.5 (CH), 128.2 (CH), 128.5 (C_{quat}), 129.4 (C_{quat}), 130.7 (C_{quat}), 131.8 (C_{quat}), 132.6 (C_{quat}), 132.9 (C_{quat}), 134.3 (C_{quat}), 135.7 (C_{quat}), 139.4 (C_{quat}), 161.4 (C_{quat}). MS (MALDI-TOF): m/z = 404.9. UV/Vis (EtOH): λ_{max} (ε) [nm] = 253 (9100), 328 (10400). IR (KBr): $\tilde{\nu}$ [cm^{-1}] = 3212 (s), 1775 (w), 1736 (w), 1719 (w), 1686 (w), 1655 (w), 1638 (w), 1576 (m), 1561 (w), 1503 (m), 1488 (m), 1458 (m), 1406 (w), 1381 (w), 1314 (w), 1289 (m), 1228 (m), 1208 (w), 1146 (w), 1091 (s), 1069 (w), 1043 (m), 1011 (w), 934 (w), 970 (w), 952 (w), 926 (w), 850 (w), 833 (s), 794 (m), 731 (w), 703 (m), 685 (w), 627 (w), 574 (w), 555 (w), 507 (w). Anal. calcd. for $C_{23}H_{17}ClN_2OS$ (404.9): C 68.22, H 4.23, N 6.92; Found: C 68.05, H 4.24, N 6.81%.

4-(4-Chlorophenyl)-5-(2-(3-chlorophenyl)-5-methyl-1*H*-indol-3-yl)-2-methyloxazole (4o)

Red solid, Mp. 208 °C. ^{1}H NMR (500 MHz, DMSO-d_6): δ 2.30 (s, 3 H), 2.51 (s, 3 H), 7.02 (s, 1 H), 7.06 (d, ^3J = 8.3 Hz, 1 H), 7.24 (d, ^3J = 8.3 Hz, 2 H), 7.37–7.32 (m, 3 H), 7.42 (m, 3 H), 7.54 (s, 1 H), 12.02 (s, 1 H). ^{13}C NMR (125 MHz, DMSO-d_6): δ 13.7 (CH_3), 21.2 (CH_3), 100.0 (C_{quat}), 111.8 (CH), 118.5 (CH), 124.8 (CH), 125.4 (CH), 126.4 (CH), 127.1 (CH), 127.8 (CH), 127.9 (C_{quat}), 128.4 (CH), 129.4 (C_{quat}), 130.6 (C_{quat}), 130.6 (CH), 131.7 (C_{quat}), 133.4 (C_{quat}), 133.5 (C_{quat}), 134.5 (C_{quat}), 134.6 (C_{quat}), 135.4 (C_{quat}), 140.4 (C_{quat}), 160.9 (C_{quat}). MS (MALDI-TOF): m/z = 432.9. UV/Vis (EtOH): λ_{max} (ε) [nm] = 305 (20300). IR (KBr): $\tilde{\nu}$ [cm^{-1}] = 3411 (m), 3221 (m), 1736 (w), 1638 (w), 1598 (m), 1585 (m), 1561 (w), 1493 (w), 1458 (m), 1406 (w), 1377 (w), 1316 (w), 1290 (m), 1203 (w), 1155 (w), 1133 (w), 1093 (s), 997 (m), 965 (w), 943 (m), 880 (w), 852 (w), 837 (m), 802 (w), 776 (w), 743 (w), 702 (w), 627 (w), 569 (w), 512 (w). Anal. calcd. for $C_{25}H_{18}Cl_2N_2O$ (433.3): C 69.29, H 4.19, N 6.46; Found: C 69.08, H 4.26, N 6.17%.

2-Methyl-5-(5-methyl-2-(thiophen-2-yl)-1*H*-indol-3-yl)-4-*p*-tolyloxazole (4p)

Brown solid, Mp. 199 °C. ^{1}H NMR (500 MHz, DMSO-d_6): δ 2.18 (s, 3 H), 2.29 (s, 3 H), 2.52 (s, 3 H), 6.94 (s, 1 H), 7.00 (d, ^3J = 8.3 Hz, 2 H), 7.03 (d, ^3J = 8.3 Hz, 1 H), 7.07–7.08 (m, 1 H), 7.38 (m, 3 H), 7.47 (d, ^3J = 5.0 Hz, 1 H), 7.50 (d, ^3J = 3.6 Hz, 1 H), 11.93 (s, 1 H). ^{13}C NMR (125 MHz, DMSO-d_6): δ 13.8 (CH_3), 20.7 (CH_3), 21.1 (CH_3), 99.3 (C_{quat}), 111.4 (CH), 118.0 (CH), 124.4 (CH), 125.1 (CH), 125.3 (CH), 127.4 (CH), 127.4 (CH), 128.5 (C_{quat}), 129.0 (CH), 129.0 (C_{quat}), 129.2 (C_{quat}), 132.6 (C_{quat}), 133.1 (C_{quat}), 134.3 (C_{quat}), 136.6 (C_{quat}), 137.2 (C_{quat}), 138.3 (C_{quat}), 161.0 (C_{quat}). MS (MALDI-TOF): m/z = 384.9. UV/Vis (EtOH): λ_{max} (ε) [nm] = 327 (9800). IR (KBr): $\tilde{\nu}$ [cm^{-1}] = 3423 (m), 3199 (m), 2920 (m), 1719 (w), 1655 (w), 1579 (m), 1520 (w), 1458 (m), 1381 (w), 1287 (m), 1230 (w), 1208 (w), 1185 (w), 1129 (w), 1088 (w), 1069 (w), 1042 (m), 994 (w), 951 (w), 851 (w), 823 (m), 796 (m), 730 (w), 702 (m), 631 (w), 507 (w). Anal. calcd. for $C_{24}H_{20}N_2OS$ (384.5): C 73.25, H 5.57, N 6.67; Found C 73.04, H 5.54, N 7.00%.

5-(5-Chloro-2-*p*-tolyl-1*H*-indol-3-yl)-2-methyl-4-*p*-tolyloxazole (4q)

Red solid, Mp. 241 °C. ^{1}H NMR (500 MHz, DMSO-d_6): δ 2.19 (s, 3 H), 2.27 (s, 3 H), 2.47 (s, 3 H), 7.00 (d, ^3J = 8.1 Hz, 2 H), 7.07 (s, 1

H), 7.18 (m, 3 H), 7.36 (d, ^3J = 8.0 Hz, 2 H), 7.43 (d, ^3J = 8.0 Hz, 2 H), 7.50 (d, ^3J = 8.6 Hz, 1 H), 12.16 (s, 1 H). ^{13}C NMR (125 MHz, DMSO-d_6): δ 13.7 (CH_3), 20.7 (CH_3), 20.8 (CH_3), 99.4 (CH_3), 113.4 (CH), 117.7 (CH), 122.4 (CH), 124.8 (C_{quat}), 125.3 (CH), 126.8 (CH), 128.2 (C_{quat}), 128.8 (C_{quat}), 129.0 (CH), 129.3 (C_{quat}), 129.5 (CH), 134.5 (C_{quat}), 135.9 (CH_{quat}), 136.5 (C_{quat}), 138.2 (C_{quat}), 138.7 (C_{quat}), 139.1 (C_{quat}), 160.7 (C_{quat}). MS (MALDI-TOF): m/z = 412.9. UV/Vis (EtOH): λ_{max} (ε) [nm] = 245 (5300), 312 (13200). IR (KBr): $\tilde{\nu}$ [cm^{-1}] = 3423 (m), 2920 (m), 1736 (w), 1719 (w), 1686 (w), 1655 (w), 1637 (w), 1589 (m), 1560 (w), 1544 (w), 1509 (w), 1491 (w), 1459 (w), 1439 (m), 1381 (w), 1297 (m), 1180 (w), 1095 (w), 1059 (m), 1000 (m), 945 (w), 926 (w), 866 (w), 824 (m), 797 (m), 733 (w), 598 (w). Anal. calcd. for $C_{26}H_{21}ClN_2O$ (412.9): C 75.63, H 5.13, N 6.78; Found: C 75.36, H 5.20, N 6.68%.

5-(5-Chloro-2-(thiophen-2-yl)-1*H*-indol-3-yl)-4-(4-chlorophenyl)-2-methyloxazole (4r)

Brown solid, Mp. 243 °C. ^{1}H NMR (500 MHz, DMSO-d_6): δ 2.54 (s, 3 H), 7.11 (m, 1 H), 7.19 (s, 1 H), 7.21 (d, ^3J = 8.6 Hz, 1 H), 7.29 (d, ^3J = 8.5 Hz, 2 H), 7.47 (d, ^3J = 8.4 Hz, 2 H), 7.50 (d, ^3J = 8.5 Hz, 1 H), 7.54 (d, ^3J = 4.2 Hz, 2 H), 12.32 (s, 1 H). ^{13}C NMR (125 MHz, DMSO-d_6): δ 13.8 (CH_3), 98.9 (C_{quat}), 113.3 (CH), 117.6 (CH), 122.9 (CH), 125.2 (C_{quat}), 126.2 (CH), 127.0 (CH), 127.7 (CH), 128.3 (CH), 128.6 (C_{quat}), 129.0 (CH), 130.5 (C_{quat}), 132.0 (C_{quat}), 132.1 (C_{quat}), 134.2 (C_{quat}), 134.5 (C_{quat}), 136.2 (C_{quat}), 138.4 (C_{quat}), 161.6 (C_{quat}). MS (MALDI-TOF): m/z = 424.9. UV/Vis (EtOH): λ_{max} (ε) [nm] = 254 (5300), 328 (7400). IR (KBr): $\tilde{\nu}$ [cm^{-1}] = 3425 (w), 3237(w), 1638 (w), 1580 (s), 1503 (w), 1473 (m), 1444 (m), 1377 (w), 1312 (m), 1293 (m), 1274 (m), 1229 (w), 1178 (w), 1092 (s), 1064 (m), 1042 (w), 1003 (m), 969 (w), 917 (w), 854 (w), 833 (m), 795 (m), 751 (w), 735 (w), 706 (s), 613 (w), 575 (w). Anal. calcd. for $C_{22}H_{14}Cl_2N_2OS$ (425.3): C 62.12, H 3.32, N 6.59; Found: C 62.03, H 3.27, N 6.37%.

5-(5-Chloro-2-(4-chlorophenyl)-1*H*-indol-3-yl)-4-(4-chlorophenyl)-2-methyloxazole (4s)

Yellow solid, Mp. 239 °C. ^{1}H NMR (500 MHz, DMSO-d_6): δ 2.50 (s, 3 H), 7.20–7.25 (m, 4 H), 7.41 (d, ^3J = 8.5 Hz, 2 H), 7.44 (d, ^3J = 8.6 Hz, 2 H), 7.53 (d, ^3J = 8.6 Hz, 1 H), 12.31 (s, 1 H). ^{13}C NMR (125 MHz, DMSO-d_6): δ 13.8 (CH_3), 99.9 (C_{quat}), 113.7 (CH), 118.1 (CH), 123.0 (CH), 125.1 (C_{quat}), 127.2 (CH), 128.4 (CH), 128.6 (C_{quat}), 128.8 (CH), 128.9 (CH), 129.8 (C_{quat}), 130.4 (C_{quat}), 131.8 (C_{quat}), 133.3 (C_{quat}), 134.5 (C_{quat}), 134.7 (C_{quat}), 137.6 (C_{quat}), 139.5 (C_{quat}), 161.2 (C_{quat}). MS (MALDI-TOF): m/z = 454.9. UV/Vis (EtOH): λ_{max} (ε) [nm] = 245 (5600), 308 (15200). IR (KBr): $\tilde{\nu}$ [cm^{-1}] = 3610 (m), 3173 (m), 1719 (w), 1638 (m), 1583 (m), 1499 (w), 1479 (s), 1443 (m), 1404 (w), 1381 (w), 1316 (w), 1294 (m), 1275 (w), 1192 (w), 1091 (s), 1063 (m), 1010 (m), 944 (m), 972 (w), 926 (w), 862 (w), 830 (s), 793 (m), 753 (w), 732 (m), 685 (w), 608 (w), 558 (w), 512 (m). Anal. calcd. for $C_{24}H_{15}Cl_3N_2O$ (453.8): C 63.53, H 3.33, N 6.17; Found: C 63.26, H 3.30, N 5.96%.

5-(5-Chloro-2-(4-chlorophenyl)-1*H*-indol-3-yl)-2-methyl-4-*p*-tolyloxazole (4t)

Brown solid, Mp. 237 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ 2.25 (s, 3 H), 2.54 (s, 3 H), 6.95 (d, ^3J = 8.1 Hz, 2 H), 7.20–7.22 (m, 3 H), 7.31–7.39 (m, 6 H), 8.68 (s, 1 H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 14.3 (CH_3), 21.3 (CH_3), 102.3 (C_{quat}), 112.4 (CH), 119.8 (CH), 124.0 (CH), 126.3 (CH), 127.1 (C_{quat}), 128.5 (CH), 128.7 (C_{quat}), 129.2 (CH), 129.3 (CH), 129.6 (C_{quat}), 129.9 (C_{quat}), 134.3 (C_{quat}), 134.8 (C_{quat}), 137.2 (C_{quat}), 137.4 (C_{quat}), 137.5 (C_{quat}), 138.7 (C_{quat}), 161.4 (C_{quat}). MS (MALDI-TOF): m/z = 432.9, 434.9. UV/Vis (EtOH): λ_{max} (ε) [nm] = 311 (7200). IR (KBr): $\tilde{\nu}$ [cm^{-1}] = 3425 (m), 1655 (m), 1587 (m), 1510 (w), 1475 (s), 1447 (s), 1383 (w), 1296 (m), 1211 (w), 1187 (w), 1100 (m), 1061 (w), 1014 (m), 946 (w), 833 (m), 799 (m), 738 (w), 611 (w), 512 (w). Anal. calcd. for $C_{24}H_{15}Cl_3N_2O$ + 0.2 CH_2Cl_2 (433.3 + 16.98): C 67.21, H 4.21, N 6.22; Found: C 67.11, H 4.03, N 5.95%.

(5-Chloro-2-(4-methoxyphenyl)-1*H*-indol-3-yl)-2-methyl-4-*p*-tolyloxazole (4u)

Yellow solid, Mp. 224.0 °C. ^{1}H NMR (500 MHz, DMSO-d_6): δ 2.50 (s, 3 H), 3.74 (s, 3 H), 6.94 (d, ^3J = 8.8 Hz, 2 H), 7.13 (s, 1 H), 7.18 (dd, ^3J = 8.6 Hz, ^4J = 1.9 Hz, 1 H), 7.25 (d, ^3J = 8.6 Hz, 2 H), 7.44 (d, ^3J = 8.8 Hz, 4 H), 7.49 (d, ^3J = 8.6 Hz, 1 H), 12.14 (s, 1 H). ^{13}C NMR (125 MHz, DMSO-d_6): δ 13.8 (CH_3), 55.2 (CH_3), 98.3 (C_{quat}), 113.3 (CH), 114.4 (CH), 117.6 (CH), 122.2 (CH), 123.3 (C_{quat}), 124.8 (C_{quat}), 127.1 (CH), 128.4 (CH), 128.4 (CH), 129.0 (C_{quat}), 130.5 (C_{quat}), 131.7 (C_{quat}), 134.5 (C_{quat}), 134.5 (C_{quat}), 139.2 (C_{quat}), 140.0 (C_{quat}), 159.6 (C_{quat}), 161.0 (C_{quat}). MS (MALDI-TOF): m/z = 449.0. UV/Vis (EtOH): λ_{max} (ε) [nm] = 252 (5600), 309 (2100). IR (KBr): $\tilde{\nu}$ [cm^{-1}] = 3425 (w), 3128 (w), 1611 (m), 1584 (m), 1544 (w), 1506 (m), 1489 (m), 1443 (m), 1382 (w), 1298 (m), 1250 (s), 1182 (m), 1093 (m), 1058 (m), 1026 (m), 1000 (m), 945 (w), 927 (w), 865 (w), 835 (m), 801 (w), 737 (w), 601 (w), 570 (w), 527 (w). Anal. calcd. for $C_{25}H_{18}Cl_2N_2O_2$ (449.3): C 66.83, H 4.04, N 6.23; Found: C 66.62, H 3.94, N 6.00%.

5-(5-Chloro-2-(furan-2-yl)-1*H*-indol-3-yl)-4-(4-chlorophenyl)-2-methyloxazole (4v)

Brown solid, Mp. 213 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ 2.60 (s, 3 H), 6.26 (d, ^3J = 3.5 Hz, 1 H), 6.36 (dd, ^3J = 3.5 Hz, ^4J = 1.8 Hz, 1 H), 7.15 (d, ^3J = 8.6 Hz, 2 H), 7.18 (dd, ^3J = 8.6 Hz, ^4J = 2.0 Hz, 1 H), 7.30 (d, ^4J = 1.8 Hz, 1 H), 7.36 (d, ^3J = 8.6 Hz, 1 H), 7.42 (d, ^3J = 1.5 Hz, 1 H), 7.52 (d, ^3J = 8.6 Hz, 2 H), 8.97 (s, 1 H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 14.3 (CH_3), 99.7 (C_{quat}), 109.4 (CH), 112.4 (CH), 112.5 (CH), 119.4 (CH), 124.0 (CH), 127.2 (C_{quat}), 127.5 (CH), 128.7 (CH), 129.2 (C_{quat}), 129.8 (C_{quat}), 130.2 (C_{quat}), 133.5 (C_{quat}), 133.8 (C_{quat}), 136.4 (C_{quat}), 138.9 (C_{quat}), 142.6 (CH), 145.2 (C_{quat}), 161.7 (C_{quat}). MS (MALDI-TOF): m/z = 408.9, 410.9. UV/Vis (EtOH): λ_{max} (ε) [nm] = 254 (2300), 320 (4200). IR (KBr): $\tilde{\nu}$ [cm^{-1}] = 3420 (m), 1719 (w), 1581 (m), 1525 (w), 1501 (w), 1468 (m), 1430 (m), 1406 (w), 1381 (w), 1335 (w), 1290 (m), 1275 (w), 1221 (m), 1200 (w), 1158 (w), 1092 (s), 1064 (m), 1007 (s), 951 (m), 884 (w), 861 (w), 832 (m), 794 (m), 735 (w), 623 (w), 589 (w), 561 (w), 508 (w). Anal. calcd. for $C_{24}H_{15}Cl_3N_2O$ + 0.09 CH_2Cl_2 (409.3 + 7.64): C 63.63, H 3.43, N 6.72. found: C 63.69, H 3.21, N 6.53%.

5-(5-Chloro-2-(furan-2-yl)-1*H*-indol-3-yl)-2-methyl-4-*p*-tolyloxazole (4w)

Brown solid, Mp. 172 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ 2.26 (s, 3 H), 2.60 (s, 3 H), 6.27 (d, ^3J = 3.5 Hz, 1 H), 6.35 (dd, ^3J = 3.5 Hz, ^4J = 1.7 Hz, 1 H), 7.01 (d, ^3J = 8.2 Hz, 2 H), 7.18 (dd, ^3J = 8.6 Hz, ^4J = 2.0 Hz, 1 H), 7.30 (d, ^3J = 1.5 Hz, 1 H), 7.34 (d,

^3J = 8.6 Hz, 1 H), 7.41 (d, ^3J = 1.7 Hz, 1 H), 7.48 (d, ^3J = 8.2 Hz, 2 H), 9.01 (s, 1 H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 14.3 (CH_3), 21.3 (CH_3), 100.1 (C_{quat}), 109.3 (CH), 112.3 (CH), 112.5 (CH), 119.5 (CH), 123.8 (CH), 126.2 (CH), 127.0 (C_{quat}), 128.8 (C_{quat}), 129.3 (CH), 129.5 (C_{quat}), 129.8 (C_{quat}), 133.8 (C_{quat}), 137.5 (C_{quat}), 137.6 (C_{quat}), 138.0 (C_{quat}), 142.4 (CH), 145.4 (C_{quat}), 161.5 (C_{quat}). MS (MALDI-TOF): m/z = 387.9, 389.0. UV/Vis (EtOH): λ_{max} (ε) [nm] = 253 (4000), 321 (9400). IR (KBr): $\tilde{\nu}$ [cm^{-1}] = 3423 (m), 3173 (m), 1719 (w), 1655 (w), 1626 (w), 1587 (m), 1561 (w), 1543 (w), 1494 (m), 1469 (m), 1433 (w), 1404 (w), 1375 (w), 1314 (w), 1291 (m), 1273 (w), 1235 (w), 1194 (w), 1164 (w), 1094 (s), 1074 (w), 1062 (m), 1011 (m), 971 (w), 945 (m), 933 (m), 885 (w), 849 (w), 832 (m), 789 (s), 756 (w), 743 (w), 716 (w), 701 (w), 687 (m), 590 (w), 508 (w). Anal. calcd. for $C_{23}H_{17}ClN_2O_2$ + 0.33 CH_2Cl_2 (388.9 + 28.0): C 67.18, H 4.27, N 6.72; Found.: C 67.58, H 4.67, N 6.75%.

5-(5-Chloro-2-(3-chlorophenyl)-1*H*-indol-3-yl)-4-(4-chlorophenyl)-2-methyloxazole (4x)

Yellow solid, Mp. 225 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ 2.56 (s, 3 H), 7.10 (d, ^3J = 8.4 Hz, 2 H), 7.18–7.25 (m, 4 H, 7.36–7.40 (m, 5 H), 8.77 (s, 1 H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 14.3 (CH_3), 102.3 (C_{quat}), 112.5 (CH), 116.4 (C_{quat}), 119.8 (CH), 124.3 (CH), 125.5 (CH), 127.2 (C_{quat}), 127.3 (CH), 127.7 (CH), 128.6 (CH), 128.9 (CH), 129.2 (C_{quat}), 130.3 (CH), 133.0 (C_{quat}), 133.3 (C_{quat}), 134.4 (C_{quat}), 135.0 (C_{quat}), 136.1 (C_{quat}), 137.0 (C_{quat}), 139.6 (C_{quat}), 161.6 (C_{quat}). MS (MALDI-TOF): m/z = 452.9, 454.9. UV/Vis (EtOH): λ_{max} (ε) [nm] = 306 (43900). IR (KBr): $\tilde{\nu}$ [cm^{-1}] = 3416 (s), 2923 (m), 1655 (w), 1583 (m), 1512 (w), 1492 (m), 1466 (m), 1446 (m), 1382 (w), 1364 (w), 1334 (w), 1281 (m), 1220 (m), 1184 (w), 1159 (w), 1105 (w), 1064 (m), 1007 (s), 950 (m), 884 (w), 861 (w), 823 (m), 798 (m), 734 (s), 561 (w), 509 (w). Anal. calcd. for $C_{24}H_{15}Cl_3N_2O$ (453.8): C 63.53, H 3.33, N 6.17; Found: C 63.28, H 3.32, N 6.17%.

5-(5-Chloro-2-(3-chlorophenyl)-1*H*-indol-3-yl)-2-methyl-4-*p*-tolyloxazole (4y)

Yellow solid, Mp. 187 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ 2.25 (s, 3 H), 2.54 (s, 3 H), 6.95 (d, ^3J = 8.2 Hz, 2 H), 7.16 (d, ^3J = 7.7 Hz, 1 H), 7.21–7.24 (m, 3 H), 7.35–7.39 (m, 5 H), 8.71 (s, 1H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 14.3 (CH_3), 21.3 (CH_3), 102.8 (C_{quat}), 112.4 (CH), 116.4 (C_{quat}), 119.9 (CH), 124.1 (CH), 125.6 (CH), 126.4 (CH), 127.1 (C_{quat}), 127.3 (CH), 128.7 (CH), 128.9 (C_{quat}), 129.1 (CH), 129.5 (C_{quat}), 130.2 (CH), 133.2 (C_{quat}), 134.4 (C_{quat}), 134.9 (C_{quat}), 136.9 (C_{quat}), 137.4 (C_{quat}), 138.6 (C_{quat}), 161.3 (C_{quat}). MS (MALDI-TOF): m/z = 432.9. UV/Vis (EtOH): λ_{max} (ε) [nm] = 314 (9600). IR (KBr): $\tilde{\nu}$ [cm^{-1}] = 3398 (s), 1638 (m), 1465 (w), 1062(w), 786 (m), 685 (m). Anal. calcd. for $C_{25}H_{18}Cl_2N_2O$ (433.3): C 69.29, H 4.19, N 6.46; Found: C 69.02, H 4.18, N 6.46%.

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Notes and references

1 B. S. Joshi, W. I. Taylor, D. S. Bhate and S. S. Karmarkar, *Tetrahedron*, 1963, **19**, 1437.
2 G. R. Pettit, J. C. Knight, D. L. Herald, R. Davenport, R. K. Pettit, B. E. Tucker and J. M. Schmidt, *J. Nat. Prod.*, 2002, **65**, 1793.
3 S. Takahashi, T. Matsunaga, C. Hasegawa, H. Saito, D. Fujita, F. Kiuchi and Y. Tsuda, *Chem. Pharm. Bull.*, 1998, **46**, 1527.
4 F. Miyake, M. Hashimoto, S. Tonsiengsom, K. Yakushijin and D. A. Horne, *Tetrahedron*, 2010, **66**, 4888; G. Guella, I. Mancini, I. N'Diaye and F. Pietra, *Helv. Chim. Acta*, 1994, **77**, 1999.
5 R. Fernández, M. J. Martín, R. Rodríguez-Acebes, F. Reyes, A. Francesch and C. Cuevas, *Tetrahedron Lett.*, 2008, **49**, 2283; N. Lindquist, W. Fenical, G. D. Van Duyne and J. Clardy, *J. Am. Chem. Soc.*, 1991, **113**, 2303.
6 Z. Cruz-Monserrate, H. C. Vervoort, R. Bai, D. J. Newman, S. B. Howell, G. Los, J. T. Mullaney, M. D. Williams, G. R. Pettit, W. Fenical and E. Hamel, *Mol. Pharmacol.*, 2003, **63**, 1273.
7 A. Nishida, M. Fuwa, Y. Fujikawa, E. Nakahata, A. Furuno and M. Nakagawa, *Tetrahedron Lett.*, 1998, **39**, 5983.
8 S. R. Naik, J. Harindran and A. B. Varde, *J. Biotechnol.*, 2001, **88**, 1.
9 D. Kumar, S. Sundaree, G. Patel and A. Kumar, *J. Heterocycl. Chem.*, 2010, **47**, 1425; D. Kumar, S. Sundaree, G. Patel and V. S. Rao, *Tetrahedron Lett.*, 2008, **49**, 867.
10 J. D. Sunderhaus and S. F. Martin, *Chem.–Eur. J.*, 2009, **15**, 1300; N. Isambert and R. Lavilla, *Chem.–Eur. J.*, 2008, **14**, 8444; A. Dömling, *Chem. Rev.*, 2006, **106**, 17; R. V. A. Orru and M. de Greef, *Synthesis*, 2003, 1471; B. B. Touré and D. G. Hall, *Chem. Rev.*, 2009, **109**, 4439; H. Bienaymé, C. Hulme, G. Oddon and P. Schmitt, *Chem.–Eur. J.*, 2000, **6**, 3321; A. Dömling and I. Ugi, *Angew. Chem., Int. Ed.*, 2000, **39**, 3168; I. Ugi, A. Dömling and B. Werner, *J. Heterocycl. Chem.*, 2000, **37**, 647; L. Weber, K. Illgen and M. Almstetter, *Synlett*, 1999, 366; R. W. Armstrong, A. P. Combs, P. A. Tempest, S. D. Brown and T. A. Keating, *Acc. Chem. Res.*, 1996, **29**, 123; I. Ugi, A. Dömling and W. Hörl, *Endeavour*, 1994, **18**, 115; G. H. Posner, *Chem. Rev.*, 1986, **86**, 831.
11 L. F. Tietze, *Chem. Rev.*, 1996, **96**, 115.
12 D. M. D'Souza and T. J. J. Müller, *Chem. Soc. Rev.*, 2007, **36**, 1095; G. Balme, E. Bossharth and N. Monteiro, *Eur. J. Org. Chem.*, 2003, 4101; K. Khanbabaee, *Nachr. Chem.*, 2003, **51**, 691; G. Battistuzzi, S. Cacchi and G. Fabrizi, *Eur. J. Org. Chem.*, 2002, 2671.
13 T. J. J. Müller, *Top. Heterocycl. Chem.*, 2010, **25**, 25; B. Willy and T. J. J. Müller, *Curr. Org. Chem.*, 2009, **13**, 1777; B. Willy and T. J. J. Müller, *ARKIVOC*, 2008, **Part I**, 195; T. J. J. Müller, *Targets in Heterocyclic Systems*, 2006, **10**, 54.
14 T. J. J. Müller and D. M. D'Souza, *Pure Appl. Chem.*, 2008, **80**, 609; T. J. J. Müller, In *"Functional Organic Materials. Syntheses, Strategies, and Applications"*, T. J. J. Müller, U. H. F. Bunz, eds, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, 2007, 179.
15 For recent reviews, see *e.g.* K. Krüger, A. Tillack and M. Beller, *Adv. Synth. Catal.*, 2008, **350**, 2153; G. R. Humphrey and J. T. Kuethe, *Chem. Rev.*, 2006, **106**, 2875; S. Cacchi and G. Fabrizi, *Chem. Rev.*, 2005, **105**, 2873; G. Zeni and R. C. Larock, *Chem. Rev.*, 2004, **104**, 2285.
16 For reviews, see *e.g.* B. Robinson, *Chem. Rev.*, 1969, **69**, 227; D. L. Hughes, *Org. Prep. Proced. Int.*, 1993, **25**, 607. For a review on mechanistic aspects, see *e.g.*; N. M. Przheval'skii, L. Y. Kostromina and I. I. Grandberg, *Chem. Heterocycl. Compd.*, 1989, **24**, 709. For a modern variation in the sense of a multiple condensation reaction, see *e.g.*; C. A. Simoneau and B. Ganem, *Tetrahedron*, 2005, **61**, 11374.
17 J. M. Zhang, P. Y. Coqueron and M. A. Ciufolini, *Heterocycles*, 2011, **82**, 949.
18 P. Wipf and C. P. Miller, *J. Org. Chem.*, 1993, **58**, 3604; P. Wipf and S. Lim, *J. Am. Chem. Soc.*, 1995, **117**, 558; A. J. Phillips, Y. Uto, P. Wipf, M. J. Reno and D. R. Williams, *Org. Lett.*, 2000, **2**, 1165; P. Wipf and J.-L. Methot, *Org. Lett.*, 2001, **3**, 1261.
19 P. Wipf, L. T. Rahman and S. R. Rector, *J. Org. Chem.*, 1998, **63**, 7132; A. Arcadi, S. Cacchi, L. Cascia, G. Fabrizi and F. Marinelli, *Org. Lett.*, 2001, **3**, 2501; P.-Y. Coqueron, C. Didier and M. A. Ciufolini, *Angew. Chem., Int. Ed.*, 2003, **42**, 1411.
20 A. S. K. Hashmi, J. P. Weyrauch, W. Frey and J. W. Bats, *Org. Lett.*, 2004, **6**, 4391.
21 E. Merkul, O. Grotkopp and T. J. J. Müller, *Synthesis*, **2009**, 502; E. Merkul and T. J. J. Müller, *Chem. Commun.*, 2006, 4817.
22 For reviews on microwave-assisted syntheses of heterocycles, see *e.g.* H. M. Hügel, *Molecules*, 2009, **14**, 4936; M. C. Bagley and M. C. Lubinu,

Top. Heterocycl. Chem., 2006, **1**, 31; E. Suna and I. Mutule, *Top. Curr. Chem.*, 2006, **266**, 49.
23 D. M. D'Souza and T. J. J. Müller, *Nat. Protoc.*, 2008, **3**, 1660; A. S. Karpov and T. J. J. Müller, *Org. Lett.*, 2003, **5**, 3451.
24 Crystallographic data (excluding structure factors) for the structure reported in this paper have been deposited with the Cambridge Crystallographic Data Centre: CCDC 834591 (**4x**). See ESI†.
25 A. O. Doroshenko, A. V. Kirichenko, V. G. Mitina and O. A. Ponomaryov, *J. Photochem. Photobiol., A*, 1996, **94**, 15.
26 A. D. Becke, *J. Chem. Phys.*, 1993, **98**, 5648; A. D. Becke, *J. Chem. Phys.*, 1993, **98**, 1372; R. G. Parr, W. Yang, *Density-Functional Theory of Atoms and Molecules*, Oxford University Press, Oxford, 1989.
27 R. Ditchfield, W. J. Hehre and J. A. Pople, *J. Chem. Phys.*, 1971, **54**, 724.
28 M. J. Frisch, G. W. Trucks, H. B. Schlegel, G. E. Scuseria, M. A. Robb, J. R. Cheeseman, J. A. Montgomery, Jr., T. Vreven, K. N. Kudin, J. C. Burant, J. M. Millam, S. S. Iyengar, J. Tomasi, V. Barone, B. Mennucci, M. Cossi, G. Scalmani, N. Rega, G. A. Petersson, H. Nakatsuji, M. Hada, M. Ehara, K. Toyota, R. Fukuda, J. Hasegawa, M. Ishida, T. Nakajima, Y. Honda, O. Kitao, H. Nakai, M. Klene, X. Li, J. E. Knox, H. P. Hratchian, J. B. Cross, V. Bakken, C. Adamo, J. Jaramillo, R. Gomperts, R. E. Stratmann, O. Yazyev, A. J. Austin, R. Cammi, C. Pomelli, J. Ochterski, P. Y. Ayala, K. Morokuma, G. A. Voth, P. Salvador, J. J. Dannenberg, V. G. Zakrzewski, S. Dapprich, A. D. Daniels, M. C. Strain, O. Farkas, D. K. Malick, A. D. Rabuck, K. Raghavachari, J. B. Foresman, J. V. Ortiz, Q. Cui, A. G. Baboul, S. Clifford, J. Cioslowski, B. B. Stefanov, G. Liu, A. Liashenko, P. Piskorz, I. Komaromi, R. L. Martin, D. J. Fox, T. Keith, M. A. Al-Laham, C. Y. Peng, A. Nanayakkara, M. Challacombe, P. M. W. Gill, B. G. Johnson, W. Chen, M. W. Wong, C. Gonzalez and J. A. Pople, *GAUSSIAN 03 (Revision B.03)*, Gaussian, Inc., Wallingford, CT, 2004.
29 M. A. Thompson and M. C. Zerner, *J. Am. Chem. Soc.*, 1991, **113**, 8210; M. A. Thompson, E. D. Glendening and D. Feller, *J. Phys. Chem.*, 1994, **98**, 10465; M. A. Thompson, *J. Phys. Chem.*, 1995, **99**, 6374; M. A. Thompson and G. K Schenter, *J. Phys. Chem.*, 1996, **100**, 14492; M. C. Zerner, G. H. Loew, R. F. Kirchner and U. T. Mueller-Westerhoff, *J. Am. Chem. Soc.*, 1980, **102**, 589.
30 As implemented in M. A. Thompson, *ArgusLab 4.0*, Planaria Software LLC: Seattle, WA, USA, 2004.
31 C. Zorn, M. Bowen, S. Majewski, J. Walker, R. Wojcik, C. Hurlbut and W. Moser, *Nucl. Instrum. Methods Phys. Res., Sect. A*, 1988, **273**, 108.

