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Note

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One-pot Formation of 1,3,4-Oxadiazol-2(*3H*)-ones and Dibenzo[*c,e*]azepines by Concomitant Cathodic Reduction of Diazonium salts and Phenanthrenequinones

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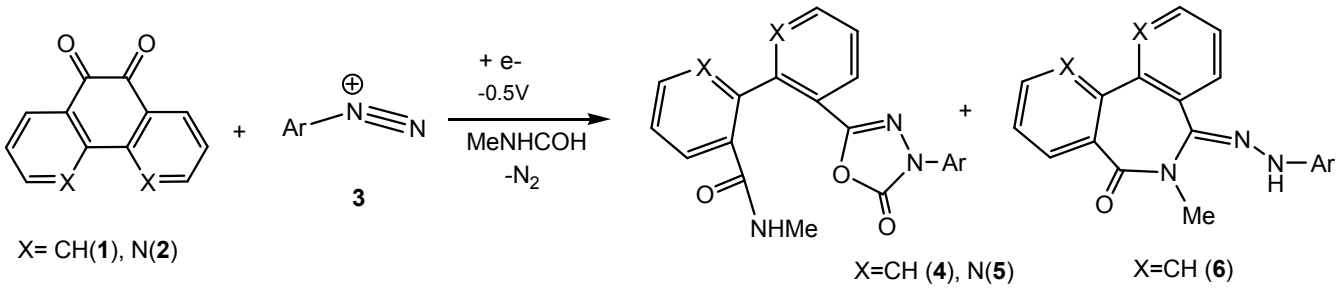


X= CH(**1**), N(**2**)

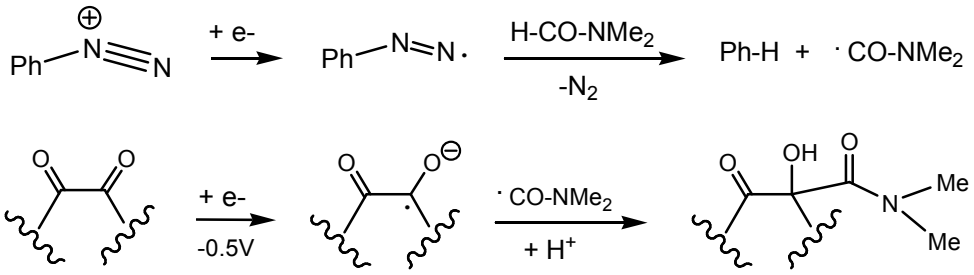
Ar= C_6H_5 (**a**), 4-MeO-C_6H_4 (**b**), 2-MeS-C_6H_4 (**c**), 4-Cl-C_6H_4 (**d**), 4-Br-C_6H_4 (**e**), 4-MeCO-C_6H_4 (**f**)

ABSTRACT

The one-pot concomitant electrochemical reduction of phenanthrenequinones (**1**, **2**) and arenediazonium salts (**3a-f**) led to the formation of 1,3,4-oxadiazol-2(*3H*)-ones (**4a-f, 5a**) and dibenzo[*c,e*]azepines (**6a-f**) when N-methylformamide is used as solvent. A new pathway, different from those previously described with another aprotic solvents, is proposed. Experimental data support a radical mechanism for the electrochemical process, followed by an internal rearrangement to give the products.

KEYWORDS: radical anion, electrode reduction, radical coupling, 1,2-quinones, diazonium salts.

In a previous work[1] we found that the concomitant electrochemical reduction of benzene diazonium tetrafluoroborate and 1,2-quinones, in DMF as solvent, afforded the corresponding introduction of a N,N-dimethylaminocarbonyl group in the quinone (Scheme 1). This radical pathway was supported by the isolation of N,N-dimethylbenzamide when the reaction was performed in the absence of quinone.



Scheme 1

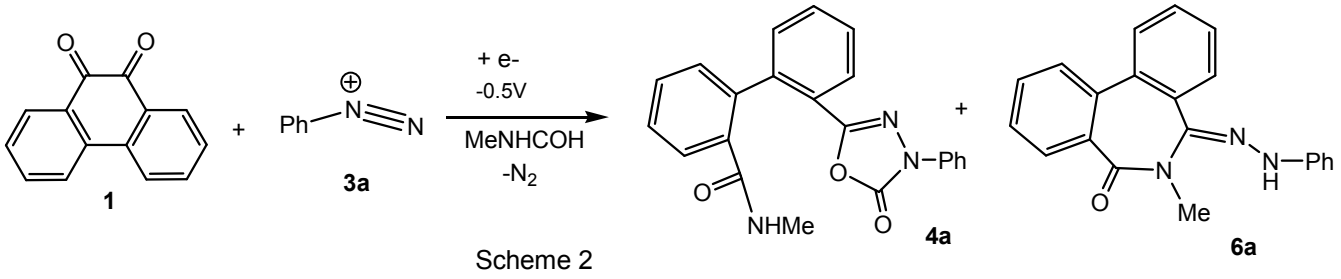
The simultaneous reduction of 1,2-quinones and diazonium salt has been carried out with different solvents such as acetonitrile, 1,2-dichloroethane, dichloromethane, chloroform, chloroacetonitrile or ethyl acetate with positive results.[1,2] Here we report a similar reaction using N-methylformamide as solvent, instead of DMF. The obtained results are significantly different, although the initial process is again a radical reaction, however the subsequent radical coupling is followed by an unexpected cleavage and rearrangement that evolves to 1,3,4-oxadiazol-2(*3H*)-ones and/or 1*H*-azepines, depending on the nature of the electrolyte used.

Surprisingly, the literature does not describe one-pot procedures to obtain substituted 1,3,4-oxadiazol-2(*3H*)-ones. Although a series of them were prepared from aldehydes, ketones, phenyl acetic acids and 1,2- or 1,3-diketones, conditions for the formation of these oxadiazolones from the precursor N-carbamoyl chlorides depend on the structure, and differ from spontaneous ring closure to those requiring bases.[3] Also, a novel process for the preparation of 3,5-disubstituted 3*H*-[1,3,4]-oxadiazol-2-ones from the reaction of N-tert-butyl-diacylhydrazines with potassium tert-butoxide followed by treatment with phosgene has been reported.[4]

A more recent synthesis of 3-methyl-5-aryl-1,3,4-oxadiazolones has been performed starting from 1-R-3-aryl-5-methyl-6-oxoverdazyl radicals.[5] Substituted 1,3,4-oxadiazol-2-ones are potent hormone-sensitive lipase (HSL) inhibitors. HSL plays an important role in the mobilization of free fatty acids (FFA) from adipocytes. In this sense, the inhibition of HSL may offer a pharmacological approach to reduce FFA levels in plasma and diminish peripheral insulin resistance in type 2 diabetes.[6] 1,3,4-Oxadiazol-2-ones have also been used in therapy as modulators of peroxisome proliferator-activated receptor delta,[7] and are useful for treating conditions modulated by a peroxisome proliferators activated receptor such as diabetes mellitus.[8]

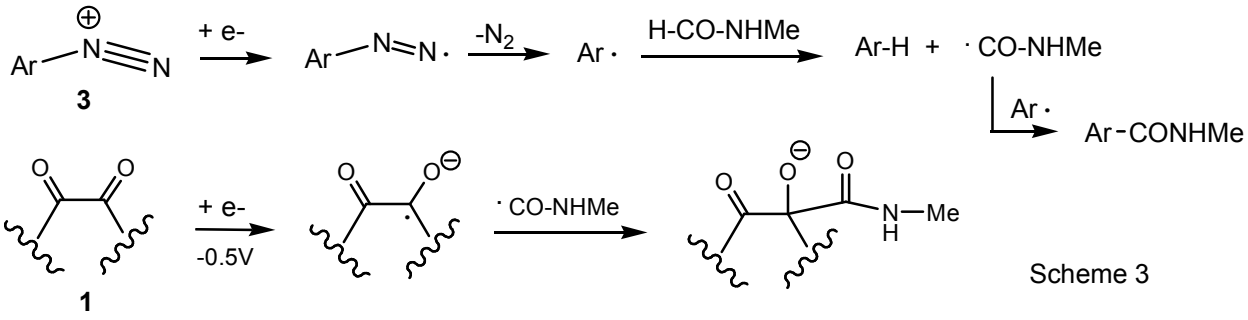
On the other hand, 1*H*-azepines result from spontaneous valence-bond isomerization of azanorcaradienes, which are themselves made by reaction of arenes with nitrenes.[9] A 1*H*-azepine ring has been described to show interesting pharmacological properties as potent and highly selective inhibitor of human neuronal nitric oxide synthase.[10]

As it has been indicated above, the concomitant electrochemical reduction of 1,2-dicarbonyl compounds (**1, 2**) and arenediazonium salts (**3**), in N-methylformamide as solvent, gives 1,3,4-oxadiazol-2(*3H*)-ones (**4a-f, 5a**) and dibenzo[*c,e*]azepines (**6a-f**), following a reaction pathway completely different from those previously described in another aprotic solvents. Transformation of **1** and **3a** to **4a** and **6a** is indicated in scheme 2.



Scheme 2

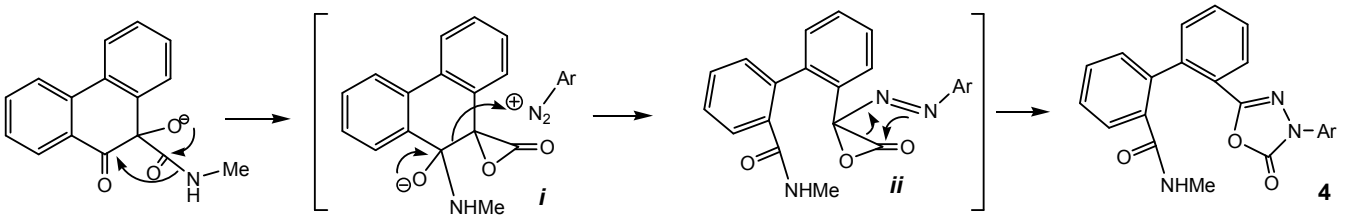
The first electrochemical step provides, once again, the radical anion of **1** and the aryl radical of **3**, which abstracts a hydrogen atom from the carbonyl position in the N-methylformamide. A further radical coupling produces the alkoxide anion indicated in scheme 3. On the other hand, we have observed that, in the absence of a dicarbonyl compound, the electrochemical reduction of the arene diazonium salt in N-methylformamide produces the corresponding N-methylbenzamide. This fact supports the radical nature of this pathway.



Scheme 3

Once the radical coupling reaction takes place, and due to the absence of steric hindrance (present when DMF was used as solvent), the remaining alkoxide anion is added to the amide carbonyl group. A similar intramolecular nucleophilic attack from the alkoxide was already observed when the reaction was carried out in 1,2-dichloroethane as solvent. In that case, 14% of spiroepoxide was obtained as a side product together with the expected 1,2-dichloroethylated derivative.[1]

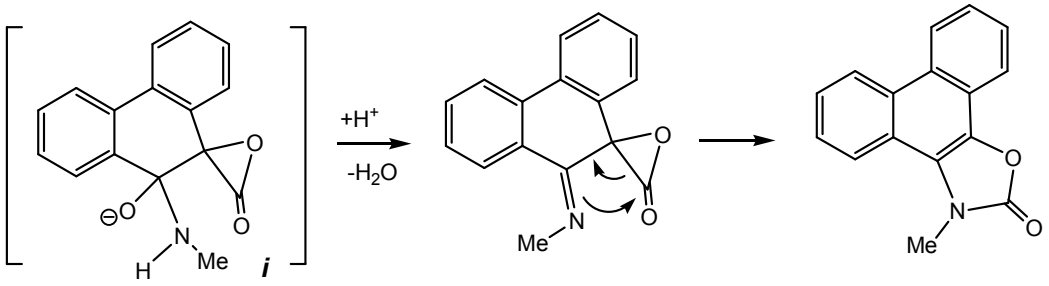
Then, after the attack of the alkoxide, the following processes should take place simultaneously: 1) migration of the leaving group to the carbonyl group of the ketone, 2) carbon-carbon bond cleavage (assisted by the diazonium salt) and 3) ring formation to afford 3,5-diaryl-1,3,4-oxadiazol-2(*3H*)-one (**4**). This plausible reaction pathway is summarized in Scheme 4.



Scheme 4

It is important to highlight that, although several steps take place in the electrochemical cell, the products are obtained in a one-pot process.

This pathway proposal is supported by the isolation of 3-methyl phenanthro[9,10-*d*]oxazol-2(*3H*)-one (< 4% yield) (see scheme 5) formed by the reaction of ***i*** with a small amount of water present in the N-methylformamide, used as solvent.

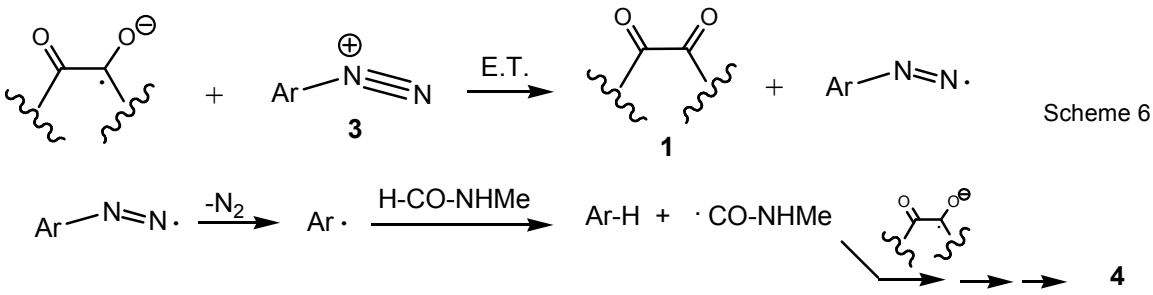


Scheme 5

It should be noticed that in the N-methylformamide molecule, two possibilities of radical hydrogen abstraction can be considered, being the hydrogen bonded to the carbonyl group faster abstracted than that bonded to the nitrogen atom, as it had been already suggested by *Cadman*[11] *et al.*

It is well known that in absence of a diazonium salt, the radical anion of **1** evolves to the starting substrate by electron transfer to the oxygen in the air. However, once the radical anion is formed and the potentiostat is switched off, if the diazonium salt is immediately added, some amount of **4** was formed, probably due to an electron-transfer process between the radical anion of **1** and the diazonium salt, as

indicated in scheme 6.



Scheme 6

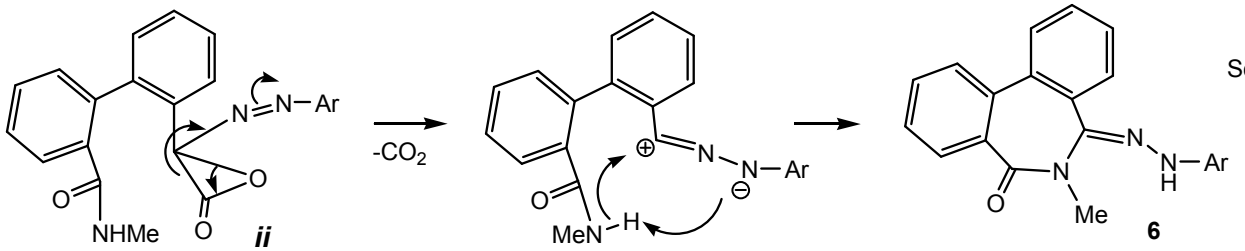
Moreover, when the lithium salt is substituted by a tetrabutylammonium salt as electrolyte, *1H*-azepine **6** is also obtained together with **4** (or **5**). The results are indicated in Table 1.

1,2-dicarbonyl compound	ArN_2^+ (**3**)	% **4** (**5**):(*)	**% 6**:(*)	% **4** (**5**):(**)	**% 6**:(**)
1:9,10-Phenanthrenequinone	**a**: C_6H_5	91	3	78	13
	b: 4-MeO-C_6H_4	60	-	8	62
	c: 2-MeS-C_6H_4	92	traces	83	traces
	d: 4-Cl-C_6H_4	88	-	-	71
	e: 4-Br-C_6H_4	82	-	1	88
	f: 4-MeCO-C_6H_4	83	5	2	84
2:1,10-Phenanthroline-5,6-dione	**a**: C_6H_5	(64)	-	(60)	-

Table 1. Obtained yields (%) of **4** (**5**) and **6** in the concomitant reduction of **1** (**2**) and **3**.

(*) SSE: N-methylformamide/$LiClO_4$. (**) SSE: N-methylformamide/Bu_4NClO_4.

The formation of the azepines **6** can be rationalized through the same intermediate (***ii***) postulated in the formation of **4**. However the azepines are formed after the loss of a carbon dioxide molecule from this intermediate, as shown in scheme 7.



Scheme 7

The possible provenance of **6** by thermal decomposition of **4** was ruled out when a reflux of **4** in DMF, during 24 h, did not afford any amount of **6**.

Finally, the hydrolysis of compound **6** was carried out, providing the corresponding N-methyl-dibenzo[*c,e*]azepine-5,7-dione, supporting the proposed structure for **6**. Nevertheless the structures of **4** and **6** were unequivocally determined by the corresponding single crystal X-ray diffraction studies on **4a**, **5a** and **6b** (see Supporting Information file).

Experimental Section

The peak potentials are given in volts (V) (*vs. Ag/Ag$^+$(3M)*). Mass spectra were determined using EI, ionizing voltage 70 eV. IR spectra of the compounds were recorded as dispersions in KBr or NaCl films. ^{1}H and ^{13}C NMR spectra were recorded in $CDCl_3$ on a 300 MHz spectrometer with tetramethylsilane (TMS) as the internal standard. The chemical shifts are given in ppm. All melting points are uncorrected.

General Electrochemical Procedure.

The electroactive diazonium tetrafluoroborates were prepared according to conventional methods.[12] The electrolyses were carried out under argon atmosphere and potentiostatic conditions. Cyclic voltammetry of **1** shows, under aprotic conditions[1], two reversible reduction peaks with values: E_{pc1}= -0.5V and E_{pc2}= -1.0V. A concentric cell with two compartments, separated by a porous (D4) glass frit diaphragm, and equipped with a magnetic stirrer was used. The temperature was maintained constant at 5 ºC with a cryostat. A mercury pool was used as the cathode (12 cm^2) and a platinum plate as the anode (2 x 2 x 0.1 cm). A reference Ag/Ag$^+$(*3M*) electrode was used. The solvent-supporting electrolyte system (SSE) was anhydrous N-methylformamide containing 0.1M lithium perchlorate or tetrabutylammonium perchlorate.

A solution of 9,10-phenanthrenequinone (**1**) or 1,10-phenanthroline-5,6-dione (**2**) (1.0 mmol in 60ml of SSE) was electrolyzed at the constant potential of -0.5V, *vs. Ag/Ag$^+$(3M)*. The diazonium salts

(**3**) (2 mmol) were added, as solid portions, to the cathodic compartment during the electrolysis (5h). Initial current of 100 mA was decreased during the reduction (except when a new diazonium salt portion was added). The complete disappearance of the radical anion red coloration in the cathode solutions (once the diazonium salt was completely added) indicated the end of the electrolysis. When the final current was close to 3mA, a charge consumption of 3F/mol was achieved.

Once the reduction was finished, the solvent in the cathodic solution was removed under reduced pressure. The residue was extracted with ether/water and the organic phase dried over Na_2SO_4 and concentrated by evaporation. The resulting products were purified by silica gel 60 (35-70 mesh) in a (30x3cm) column, using mixtures CH_2Cl_2/EtOH as eluents. Spectroscopic description of the obtained compounds is given below. Yields are given as isolated product in (*) SSE: N-methylformamide/$LiClO_4$ or (**) SSE: N-methylformamide/Bu_4NClO_4.

3-Methyl phenanthro[9,10-*d*]oxazol-2(*3H*)-one: Mp 208-210 ºC.[Lit.[13] 210-211ºC]. MS m/z (relative intensity) EI: 250 (M^++1, 21), 249 (M^+, 100), 234(7), 220(40), 206(18), 192(34), 177(12), 165(56), 151(15).

N-Methyl-5*H*-dibenzo[*c,e*]azepine-5,7(6*H*)-dione: Mp 161-163 ºC.[Lit.[14] 165-167 ºC]. IR (KBr) ν/cm^{-1} = 3058, 2924, 1596, 1504, 1445, 1281, 1224, 1029, 752, 725. MS m/z (relative intensity) EI: 237 (M^+, 19), 209 (100), 192(24), 181(30), 165(31), 152(28) 126(4), 76(12).

5-[2-(2´-(methylcarbamoyl)phenyl)phenyl]-3-phenyl-1,3,4-oxadiazol-2(*3H*)-one (**4a**): (337 mg, 91%)*. Mp 129-132 ºC. IR (KBr) ν/cm^{-1} = 3370, 3062, 2924, 1782, 1649, 1597, 1501, 1373, 1145, 753. ^{1}H NMR (300 MHz; $CDCl_3$) δ (ppm): 2.78 (d, 3H, J=5.0 Hz), 5.9 (bs, 1H), 7.1-7.6 (m, 11H), 7.8-7.9 (m, 2H). ^{13}C NMR (75.4 MHz, $CDCl_3$) δ: 26.6, 117.8, 122.0, 126.1, 127.5, 128.1, 128.3, 128.4, 129.7, 130.0, 130.1, 131.2, 131.6, 132.0, 138.3, 140.2, 165.5, 169.7. MS m/z (relative intensity) EI: 371(M^+, 18), 314(24), 313(100), 269 (15), 204(21), 194(35), 167(16), 151(14), 91(8), 77(5). Anal. Calc. for $C_{22}H_{17}N_3O_3$: C, 71.16; H, 4.58; N, 11.32. Found: C, 70.86; H, 4.80; N, 11.07.

5-[2-(2´-(methylcarbamoyl)phenyl)phenyl]-3-(4-methoxyphenyl)-1,3,4-oxadiazol-2(*3H*)-one (**4b**): (240 mg, 60%)*. Mp 62-64 ºC. IR (KBr) ν/cm^{-1} = 3401, 3058, 2929, 1771, 1653, 1513, 1380, 1251,

1029, 833, 757. ^{1}H NMR (300 MHz; $CDCl_3$) δ (ppm): 2.64 (d, 3H, J=5.0 Hz), 3.81(s, 3H), 5.8(bs, 1H), 6.87(d, 2H, J=9.4 Hz), 7.18-7.22(m, 1H), 7.4-7.5(m, 3H), 7.57(t, 2H, J=8.0 Hz), 7.65-8.0(m, 4H). ^{13}C NMR (75.4 MHz, $CDCl_3$) δ: 26.6, 55.5, 114.4, 119.7, 127.6, 127.7, 127.9, 128.1, 128.2, 128.3, 128.6, 129.2, 129.8, 129.9, 130.2, 131.2, 131.5, 150.4, 153.2, 157.7, 169.6. MS m/z (relative intensity) EI: 402 (M^++1, 20), 401(M^+, 76), 343(49), 222(100), 204(41), 195(25), 178(18), 151(22), 121(47), 106(12). Anal. Calc. for C_{23} H_{19} N_3 O_4: C, 68.83; H, 4.74; N, 10.47. Found: C, 68.57; H, 4.55; N, 10.72.

5-[2-(2´-(methylcarbamoyl)phenyl)phenyl]-3-[2-(methylthio)phenyl]-1,3,4-oxadiazol-2(*3H*)-one (**4c**): (383 mg, 92%)*. Mp 92-94 ºC. IR (KBr) ν/cm^{-1} = 3421, 3051, 2921, 1786, 1652, 1534, 1479, 1337, 974, 751. ^{1}H NMR (300 MHz; $CDCl_3$) δ (ppm): 2.3(s, 3H), 2.55(d, 3H, J=5.0 Hz), 6.0(bs, 1H), 7.12(t, 2H, J=7.6 Hz), 7.19(t, 2H, J=8.9 Hz), 7.28-7.36(m, 4H), 7.40-7.51(m, 3H), 7.80(d, 1H, J=7.6 Hz). ^{13}C NMR (75.4 MHz, $CDCl_3$) δ: 15.9, 26.6, 122.3, 125.7, 127.2, 127.7, 127.9, 128.1, 128.8, 129.7, 129.8, 130.1, 131.4, 131.5, 132.2, 136.8, 137.0, 137.7, 140.4, 151.8, 154.0, 170.0. MS m/z (relative intensity) EI: 418(M^++1, 4), 417(M^+, 14), 360(26), 359(100), 268(7), 238(16), 206(28), 194(31), 181(52), 166(23), 152(25), 136(72), 122(21), 78(9). Anal. Calc. for C_{23} H_{19} N_3 O_3 S: C, 66.19; H, 4.56; N, 10.07; S, 7.67. Found: C, 65.87; H, 4.31; N, 9.80; S, 7.95.

5-[2-(2´-(methylcarbamoyl)phenyl)phenyl]-3-(4-chlorophenyl)-1,3,4-oxadiazol-2(*3H*)-one (**4d**): (356 mg, 88%)*. Mp 59-61 ºC. IR (KBr) ν/cm^{-1} = 3411, 3058, 2921, 1785, 1647, 1534, 1495, 1377, 1095, 974, 934, 830, 736. ^{1}H NMR (300 MHz; $CDCl_3$) δ (ppm): 2.56(d, 3H, J=4.7 Hz), 5.62(bs, 1H), 7.10-7.16(m, 1H), 7.17-7.43(m, 7H), 7.48(t, 2H, J= 6.8Hz), 7.54-7.63(m, 1H), 7.83(d, 1H, J=6.8 Hz). ^{13}C NMR (75.4 MHz, $CDCl_3$) δ: 26.5, 118.9, 121.7, 127.5, 128.0, 128.2, 128.3, 129.1, 129.8, 129.9, 131.1, 131.3, 131.6, 134.3, 136.0, 138.1, 140.2, 150.0, 153.3, 169.2. MS m/z (relative intensity) EI: 407(M^++2, 6), 405(M^+, 18), 349(35), 347(100), 303(8), 268(9), 222(27), 204(36), 194(51), 167(28), 151 (21), 125(16), 90(18), 63(9). Anal. Calc. for C_{22} H_{16} Cl N_3 O_3: C, 65.10; H, 3.95; N, 10.36. Found: C, 64.88; H, 4.11; N, 10.56.

5-[2-(2´-(methylcarbamoyl)phenyl)phenyl]-3-(4-bromophenyl)-1,3,4-oxadiazol-2(*3H*)-one (**4e**): (368 mg, 82%)*. Mp 60-62 ºC. IR (KBr) ν/cm^{-1} = 3414, 3060, 2962, 1784, 1653, 1540, 1492, 1262,

1096, 1035, 803. ^{1}H NMR (300 MHz; $CDCl_3$) δ (ppm): 2.57(d, 3H, J=5.0 Hz), 5.62(bs, 1H), 7.10-7.18(m, 1H), 7.30-7.42(m, 7H), 7.42-7.56(m, 2H), 7.56-7.64(m, 1H), 7.83(dd, 1H, J_1=7.6 Hz, J_2=1.5 Hz). ^{13}C NMR (75.4 MHz, $CDCl_3$) δ: 26.6, 119.2, 119.3, 121.8, 127.6, 128.1, 128.3, 128.4, 129.9, 130.0, 131.2, 131.7, 132.2, 134.9, 136.1, 138.2, 140.3, 149.9, 153.5, 169.3. MS m/z (relative intensity) EI: 451(M^++2, 19), 449(M^+, 18), 394(22), 393 (90), 392(22), 391(90), 350(9), 348(9), 296(12), 268(26), 239(12), 222(66), 204(72), 194(100), 167(50), 151(51), 90(49), 63(36). Anal. Calc. for C_{22} H_{16} Br N_3 O_3: C, 58.67; H, 3.56; N, 9.33. Found: C, 58.72; H, 3.81; N, 9.07.

5-[2-(2´-(methylcarbamoyl)phenyl)phenyl]-3-(4-acetylphenyl)-1,3,4-oxadiazol-2(*3H*)-one (**4f**): (342 mg, 83%)*. Mp 61-63 ºC. IR (KBr) ν/cm^{-1} = 3419, 2923, 1786, 1643, 1602, 1377, 1266, 933, 841, 770. ^{1}H NMR (300 MHz; $CDCl_3$) δ (ppm): 2.61 (s, 3H), 2.67 (d, 3H, J=4.9 Hz), 5.7(bs, 1H), 7.44(d, 1H, J=7.4 Hz), 7.48-7.68(m, 7H), 7.68-7.74(m, 1H), 7.94-8.0(m, 3H). ^{13}C NMR (75.4 MHz, $CDCl_3$) δ: 26.5, 26.6, 117.2, 121.7, 127.6, 128.1, 128.2, 128.3, 129.6, 129.9, 130.0, 131.1, 131.8, 133.2, 136.0, 138.2, 139.5, 148.8, 149.8, 171.8, 196.7. MS m/z (relative intensity) EI: 414 (M^++1, 4), 413(M^+, 13), 356(24), 355(100), 312(4), 297(17), 269(9), 222(11), 204(18), 194(33), 166(17), 151(12). Anal. Calc. for C_{24} H_{19} N_3 O_4: C, 69.73; H, 4.60; N, 10.17. Found: C, 70.07; H, 4.91; N, 9.89.

5-[2-(3-(methylcarbamoyl)-pyridin-2-yl-)pyridin-3-yl-]-3-phenyl-1,3,4-oxadiazol-2(*3H*)-one (**5a**): (238 mg, 64%)*. Mp 161-162 ºC. IR (KBr) ν/cm^{-1} = 3415, 3056, 2925, 1773, 1663, 1578, 1378, 1043, 735. ^{1}H NMR (300 MHz; $CDCl_3$) δ (ppm): 2.72 (d, 3H, J=5.0 Hz), 6.4 (bs, 1H), 7.15 (t, 1H, J=8.0 Hz), 7.3 (t, 2H, J=8.0 Hz), 7.4-7.54 (m, 4H), 8.06 (dd, 1H, J_1=7.9 Hz, J_2=1.6 Hz), 8.28 (dd, 1H, J_1=8.2 Hz, J_2=1.6 Hz), 8.64 (dd, 1H, J_1=4.6 Hz, J_2=1.6 Hz), 8.72 (dd, 1H, J_1=4.6 Hz, J_2=1.6 Hz). ^{13}C NMR (75.4 MHz, $CDCl_3$) δ: 26.7, 117.9, 119.6, 123.3, 123.5, 126.1, 129.0, 136.0, 136.3, 136.6, 150.3, 150.6, 151.8, 155.0, 156.4, 167.4. MS m/z (relative intensity) CI: 414(M^++41, 6), 402(M^++29, 19), 374(M^++1, 40), 343 (100), 329(21), 269(11), 207(14). Anal. Calc. for C_{20} H_{15} N_5 O_3: C, 64.34; H, 4.02; N, 18.77. Found: C, 63.98; H, 4.23; N, 18.91.

N-Methyl-dibenzo[c,e]azepine-5-one-7-(ylidene-2-phenylhydrazine) (**6a**):

(43 mg, 13%)**. Mp 74-75 ºC. IR (KBr) ν/cm^{-1} = 3276, 2923, 1642, 1602, 1445, 1372, 1252, 1120, 752, 736, 696. ^{1}H NMR (300 MHz; $CDCl_3$) δ (ppm): 2.0(bs, 1H), 3.24(s, 3H), 6.82(t, 1H, J=7.3 Hz), 7.0(d, 1H, J=7.6 Hz), 7.16(d, 1H, J=7.6 Hz), 7.3-7.55(m, 5H), 7.57(d, 1H, J=7.6 Hz), 7.67(t, 1H, J=7.9 Hz), 7.86(d, 1H, J=7.6 Hz), 7.97(d, 1H, J=7.9 Hz), 8.14(d, 1H, J=7.9 Hz). ^{13}C NMR (75.4 MHz, $CDCl_3$) δ: 31.8, 113.6, 121.2, 128.0, 128.1, 128.3, 128.5, 129.3, 129.4, 129.8, 130.7, 131.5, 132.2, 132.9, 135.8, 137.1, 137.3, 143.7, 169.0. MS m/z (relative intensity) EI: 328(M^++1, 22), 327(M^+, 89), 269(17), 222(100), 204(54), 195(28), 178(17), 165(35), 151(15), 91(3), 77(5). Anal. Calc. for C_{21} H_{17} N_3 O: C, 77.06; H, 5.20; N, 12.84. Found: C, 77.21; H, 5.01; N, 12.66.

N-Methyl-dibenzo[c,e]azepine-5-one-7-(ylidene-2-(4-methoxyphenyl)hydrazine) (**6b**):

(220 mg, 62%)**.Mp 213-215 ºC. IR (KBr) ν/cm^{-1} = 3264, 3058, 2926, 1643, 1514, 1444, 1366, 1236, 1035, 826, 740. ^{1}H NMR (300 MHz; $CDCl_3$) δ (ppm): 3.27(s, 3H), 3.73(s, 3H), 6.8(d, 2H, J=9.1 Hz), 7.0(d, 2H, J=9.1 Hz), 7.4-7.55(m, 6H), 7.6(d, 1H, J=7.0 Hz), 7.9(d, 1H, J=7.9 Hz). ^{13}C NMR (75.4 MHz, $CDCl_3$) δ: 31.6, 55.7, 114.5, 114.6, 125.9, 127.9, 128.0, 128.2, 128.4, 129.3, 129.6, 129.9, 130.6, 130.8, 131.2, 131.4, 137.0, 137.7, 154.3, 168.9. MS m/z (relative intensity) EI: 358(M^++1, 19), 357(M^+, 72), 300(3), 222 (100), 204 (44), 195(25), 178(19), 165(32), 151(22), 122(41), 92(13), 77(8), 65(5). Anal. Calc. for C_{22} H_{19} N_3 O_2: C, 73.95; H, 5.32; N, 11.76. Found: C, 74.22; H, 5.60; N, 11.49.

N-Methyl-dibenzo[c,e]azepine-5-one-7-(ylidene-2-(4-chlorophenyl)hydrazine) (**6d**):

(255 mg, 71%)**. Mp 226-228 ºC. IR (KBr) ν/cm^{-1} = 3276, 3058, 2923, 1637, 1616, 1506, 1492, 1370, 1250, 1087, 824, 737. ^{1}H NMR (300 MHz; $CDCl_3$) δ (ppm): 3.22(s, 3H), 6.94(d, 2H, J=8.9 Hz), 7.12 (d, 2H, J=8.9 Hz), 7.3-7.55(m, 7H), 7.58 (d, 1H, J=7.8 Hz), 7.82(d, 1H, J=7.8Hz). ^{13}C NMR (75.4 MHz, $CDCl_3$) δ: 31.9, 114.0, 114.3, 128.0, 128.3, 128.6, 129.2, 129.4, 129.9, 130.7, 131.6, 132.7, 136.2, 136.7, 137.0, 137.2, 142.4, 169.2.. MS m/z (relative intensity) EI: 363(M^++2, 21), 361(M^+, 60), 304(12), 269(7), 222 (100), 204(58), 195(31), 178(18), 167(31), 165(36), 151(23), 125(10), 111(12), 90(10), 75(8). Anal. Calc. for C_{21} H_{16} Cl N_3 O: C, 69.71; H, 4.43; N, 11.62. Found: C, 69.50; H, 4.61; N, 11.53.

N-Methyl-dibenzo[c,e]azepine-5-one-7-(ylidene-2-(4-bromophenyl)hydrazine) (**6e**):

(357 mg, 88%)**. Mp 232-234ºC. IR (KBr) ν/cm^{-1} = 3280, 3058, 2931, 1636, 1593, 1497, 1487, 1368, 1250, 1140, 1121, 1069, 819, 762, 737. ^{1}H NMR (300 MHz; $CDCl_3$) δ (ppm): 3.14(s, 3H), 6.81(d, 2H, J=8.9 Hz), 7.1 (d, 2H, J=8.9 Hz), 7.2-7.5(m, 7H), 7.62 (d, 1H, J=7.6 Hz), 7.84(s, 1H). ^{13}C NMR (75.4 MHz, $CDCl_3$) δ: 32.0, 112.9, 115.0, 127.9, 128.0, 128.3, 128.5, 129.4, 129.8, 130.7, 131.5, 131.9, 132.6, 135.8, 136.8, 137.0, 137.2, 142.9, 168.7. MS m/z (relative intensity) EI: 407(M^++2, 17), 405(M^+, 17), 350(4), 348(4), 269(6), 222 (100), 204(52), 195(28), 178(19), 165(35), 151(21), 91(6), 76(4), 63(8). Anal. Calc. for C_{21} H_{16} Br N_3 O: C, 62.07; H, 3.94; N, 10.34. Found: C, 62.21; H, 4.13; N, 10.24.

N-Methyl-dibenzo[c,e]azepine-5-one-7-(ylidene-2-(4-acetylphenyl)hydrazine) (**6f**):

(310 mg, 84%)**. Mp 138-140 ºC. IR (KBr) ν/cm^{-1} = 3256, 3059, 2928, 1654, 1598, 1522, 1444, 1359, 1261, 1108, 835, 740. ^{1}H NMR (300 MHz; $CDCl_3$) δ (ppm): 2.5(s, 3H), 3.3(s, 3H), 7.1(d, 2H, J=8.5 Hz), 7.27-7.67(m, 7H), 7.85(d, 3H, J=8.9 Hz), 8.0(s, 1H). ^{13}C NMR (75.4 MHz, $CDCl_3$) δ: 26.3, 32.2, 112.7, 127.9, 128.0, 128.4, 128.6, 129.4, 130.0, 130.3, 130.4, 130.7, 131.6, 132.6, 136.5, 136.9, 137.1, 137.6, 147.5, 168.7, 196.5. MS m/z (relative intensity) EI: 370(M^++1, 23), 369(M^+, 98), 312(7), 297(16), 269(7), 222 (100), 204 (71), 195(39), 178(21), 165(42), 151(22), 91(8), 77(6). Anal. Calc. for C_{23} H_{19} N_3 O_2: C, 74.80; H, 5.15; N, 11.38. Found: C, 74.65; H, 5.33; N, 11.46.

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Supporting Information. IR, MS and NMR (^{1}H and ^{13}C) spectra of **4, 5** and **6** are included. Ortep drawing of compounds **4a**, **5a** and **6b**, as well as Crystallographic information files (CIF) for **4a**, **5a** and **6b** are provided. This material is available free of charge via the Internet at http://pubs.acs.org/.

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