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Microwave-Assisted Graphite-Support Synthesis of Imidazolones

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Abstract 5(4*H*)-Oxazolones react with ammonium acetate under microwave irradiation and using graphite as support in an eco-friendly process. The reaction was carried out under solvent-free conditions and the imidazolones were obtained quantitatively. Moreover the reaction time was reduced too.

Keywords Graphite · Imidazolone · Microwave irradiation

1 Introduction

Imidazolones have received considerable attention over the last few years due to their interesting biological activities. Some imidazolones exhibited promising pharmacological activities while some of its derivatives have been successfully applied in crop protection. Therefore, these compounds have become an attractive target for combinatorial chemistry groups involved in drug discovery and crop protection. However, attempts have been reported to synthesize these compounds by several other methods via solution or solid phase. It is notable that in most solid phase approaches the imidazolone ring is formed by an intramolecular nucleophilic attack of a guanidine moiety onto an ester or amid carbonyl [1–3].

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5(4*H*)-Imidazolones were obtained by condensing glycine ester of acetimidic or phenylacetimidic acid in the presence of solvents, such as benzene, dioxane and acetone [4–7].

During the last 15 years numerous papers dealing with the use of microwave (MW) irradiation, rather than conventional heating, in organic and inorganic chemistry have reported dramatic reductions in reaction time and significant enhancement of yields and purity of the products despite the possibility of operating with pressurized reactors.

However, MW irradiation of chemical reactions involving low boiling reagents and/or products can involve serious safety problems. Consequently, MW-assisted solvent-free reactions ("dry media") have been widely investigated in organic synthesis. Because most organic compounds do not interact appreciably with MW irradiation, therefore, such a support could be an ideal "sensitizer", able to absorb, convert, and transfer energy provided by a MW source to the chemical reagents [8, 9].

For reactions which require high temperatures the idea of using a reaction support which takes advantage of both strong MW coupling and strong adsorption of organic molecules has enthused great interest. Amorphous carbon and graphite, in their powdered form, if irradiated at 2.45 GHz, rapidly (within 1 min) reach very high temperatures (>1,300 K) and this property has been used to explain MW-assisted syntheses of inorganic solids. In these syntheses carbon is a secondary suscepter which assists the initial heating but does not react with other reactants [10].

We selected graphite as the support, which, besides being inexpensive and nontoxic, has not been reported to be used for this synthesis.

2 Experimental

Melting points were determined on a Gallenkamp melting point apparatus and are uncorrected. Mass spectra were obtained and SHIMADZU QP 1100EX. IR spectra were recorded with a MATTSON 1000 FT-IR spectrophotometer. Nuclear magnetic resonance spectra were recorded on a BRUKER DRX-500 AVANCE spectrometer using tetramethylsilan (TMS) as an internal standard. All the reactions were carried out in an unmodified domestic microwave oven BC380W having a maximum output of 900 W operating at 2,450 MHz.

3 General Procedures

3.1 Synthesis of 2-Phenyl-5(4*H*)-oxazolone Derivatives

A mixture of finely divided, anhydrous sodium acetate (0.02 mol), hippuric acid (0.01 mol), aromatic aldehyde (0.01 mol), and acetic anhydride (35 ml) was heated with intermittent shaking until the mixture had gone from a pink, semisolid mass to a deep orange liquid. The mixture was then cooled to room temperature and the crystalline product, which got separated, was removed by filtration. The crude product was recrystallized from ethanol.

3.2 Synthesis of 2-Phenyl-5(4*H*)-imidazolone Derivatives

The appropriate 2-phenyl-5(4*H*)-oxazolone (0.01 mol), ammonium acetate (0.1 mol), graphite (0.2 g) were introduced into a beaker. The mixture was heated for the appropriate time. About 40cc of DMF was added to the mixture and was heated for 10 min and then filtered. The filtrate was mixed with water and the precipitated crystals were filtered off and recrystallized from 95% ethanol.

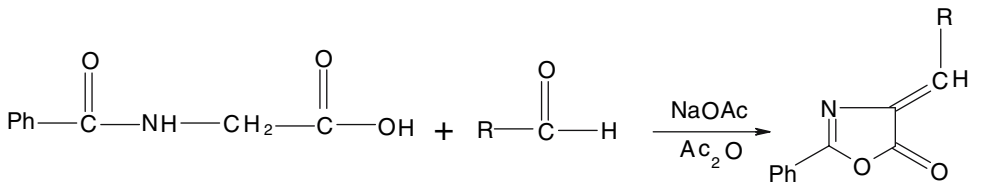
All the products obtained were characterized by IR, ^{13}C NMR and ^{1}H NMR spectroscopy (Table 1).

4 Results and Discussion

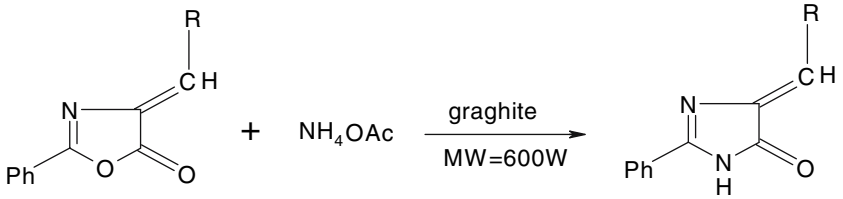
2-Phenyl-5(4*H*)-oxazolones were prepared by Erlenmeyer method. In it an aromatic aldehyde is condensed with hippuric acid in the presence of acetic anhydride and, usually, sodium acetate. Then 2-phenyl-5(4*H*)-oxazolone is converted to 2-phenyl-5(4*H*)-imidazolone via ring opening and then cyclization takes place with ammonium acetate on graphite (Scheme 1). It seems ammonia attacks on carbonyl group in 2-phenyl-5(4*H*)-oxazolone as a nucleophile

Table 1 Spectral data

Products	IR (KBr)/υ (cm^{-1})	^{1}H NMR (DMSO)/δ (ppm)	^{13}C NMR (DMSO)/δ (ppm)
3a	3180, 1716	7.04–8.34 (m, 11H, ArH and vinyl); 12.12 (s, 1H, NH)	125.94, 128.28, 128.83, 129.64, 129.91, 130.89, 132.95, 133.45, 135.25, 141.32, 161.76, 172.91
3b	3131, 1716	7.04–8.36 (m, 10H, vinyl and ArH); 12.16 (s, 1H, NH)	124.33, 128.35, 128.71, 129.72, 129.91, 133.58, 134.19, 134.49, 135.40, 141.71, 162.18, 172.78
3c	3156, 1716	7.19–9.5 (m, 9H, ArH and vinyl); 12.29 (s, 1H, NH)	117.79, 128.44, 128.57, 128.79, 129.92, 130.13, 131.59, 133.94, 134.82, 135.68, 136.37, 142.98, 163.74, 172.69
3d	3180, 1716	3.84 (s, 3H, OCH_3); 7.02–8.32 (m, 10H, vinyl and ArH); 12.02 (s, 1H, NH)	54.22, 115.30, 126.28, 128.01, 128.05, 129.02, 129.86, 133.09, 134.93, 139.43, 160.32, 161.75, 172.83
3e	3180, 1716	3.91 (s, 3H, OCH_3); 7.09–8.93 (m, 10H, vinyl and ArH); 12.09 (s, 1H, NH)	112.18, 119.06, 121.68, 123.52, 128.21, 128.89, 129.88, 132.80, 133.14, 133.32, 140.72, 159.45, 161.38, 172.95
3f	3180, 1716	3.02–3.08 (s, 6H, CH_3); 6.80–8.19 (m, 10H, vinyl and ArH); 11.80 (s, 1H, NH)	38.72, 112.68, 122.82, 127.70, 127.83, 129.46, 129.75, 132.45, 134.95, 137.20, 152.30, 157.97, 172.61
3g	3156, 1716	6.78–8.18 (m, 9H, vinyl, furyl and ArH); 10.12 (s, 1H, NH)	113.12, 114.63, 119.13, 128.22, 128.81, 129.86, 133.30, 138.81, 147.26, 151.61, 60.89, 172.25
3h	3131, 1716	7.19–8.17 (m, 9H, vinyl, thienyl and ArH); 12.07 (s, 1H, NH)	120.35, 128.12, 128.58, 128.85, 129.89, 133.21, 135.49, 135.69, 138.84, 138.95, 160.01, 171.96
3i	3180, 1716	2.35 (s, 3H, CH_3); 7.01–8.22 (m, 10H, vinyl and ArH); 12.09 (s, 1H, NH)	22.10, 126.20, 128.19, 128.92, 129.87, 130.32, 132.56, 132.99, 133.27, 140.63, 141.02, 161.13, 172.89



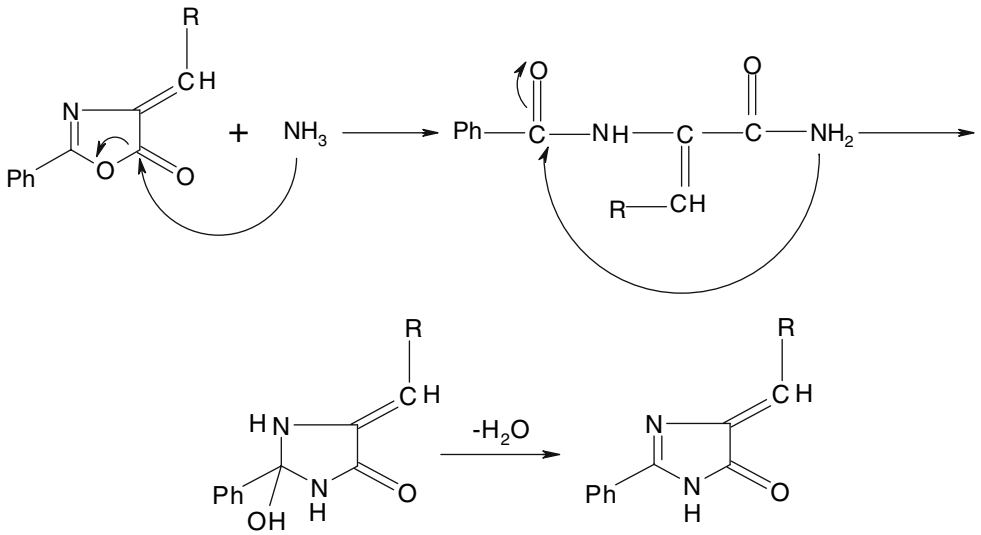
(1) (2)



(3)

1a) Benzaldehyde	**1f)** 4-(N,N-Dimethylamino)benzaldehyde
1b) 4-Chlorobenzaldehyde	**1g)** Furfural
1c) 2,4-Dichlorobenzaldehyde	**1h)** Thiophencarbaxaldehyde
1d) 4-Methoxybenzaldehyde	**1i)** 4-Methyl benzaldehyde
1e) 2-Methoxybenzaldehyde	

Scheme 1



Scheme 2

then an intramolecular condensation occurs and 2-phenyl-5(4*H*)-imidazolones are obtained (Scheme 2).

All reactions were performed in solvent-free and in the presence of graphite. The role of graphite as a support allows the temperature of reaction to increase rapidly, so that the time of reaction decreases. It should be mentioned that in the absence of graphite, lower yields were obtained and much longer times were required (Table 2).

Coupling of these two techniques, that is, organic reactions using supported reagents with microwave irradiation, has been fielded, which has shown excellent results leading to the development of many reaction procedures, which are environmental friendly falling in the domain of green chemistry.

In conclusion, a reliable, rapid and environmentally benign method for synthesizing 4-arylidene-2-phenyl-5(4*H*)-imidazolones has been developed, which involves the use of inexpensive and relatively nontoxic reagents and graphite under microwave irradiation. The advantage of this method are high yields of the products, short reaction

Table 2 Synthesis of 2-phenyl-5(4*H*)-imidazolones derivatives under solvent-free condition and microwave irradiation using the graphite (power = 600 W)

Products	R	Time (min)[a]	Yield (%)	m.p. (°C)
3a	C_6H_5	3(12)	85(73)	272–273
3b	4-ClC_6H_4	5(15)	91(80)	289–290
3c	2,4-$Cl_2C_6H_3$	4(15)	97(85)	273–274
3d	4-$MeOC_6H_4$	3(12)	84(72)	289–290
3e	2-$MeOC_6H_4$	4(15)	71(59)	254–255
3f	4-$Me_2NC_6H_4$	2(10)	80(70)	268–269
3g	C_4H_3O	3(12)	87(76)	266–267
3h	C_4H_3S	2(10)	80(69)	291–292
3i	4-MeC_6H_4	4(15)	75(62)	288–289

[a] Values in parentheses are taken in absence of graphite

times, easing of work-up and low cost make the above method advantageous in comparison to other existing methods.

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References

1. Lang UEW (2002) Tetrahedron Lett 43:6857–6860
2. Saravanan S, Selvan PS, Gopal N, Gupta JK, De B (2005) Arch Pharm Chem Life Sci 338:488–492
3. Cherouvrier JR, Carreaux F, Bazureau (2002) Tetrahedron Lett 43:3581–3584
4. Verschave P, Vekemans J, Hoornaert G (1984) Tetrahedron 40(12):2395–2404
5. Cornforth JW, Huang HT (1948) J Chem Soc 731–735
6. Kjaer A (1953) Acta Chem Scand 7:1030–1035
7. Lehr H, Karlan S, Goldberg MW (1953) J Am Chem Soc 53:3640–3645
8. Yadav LDS, Singh S (2003) Synthesis 1:63–66
9. Kidwai M (2001) Pure Appl Chem 73(1):147–151
10. Perreux L, Loupy A (2002) Microwaves in organic synthesis. Wiley-VCH, Germany