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Research Article

Synthesis of 2, 5-disubstituted-1, 3, 4-oxadiazole derivatives

Sanwar Mal Solet, Neetesh Kumar Sharma*, Dr. Raghvendra Singh Bhadauria

¹ PhD Scholar, Sun Rise University, Alwar, Rajasthan, India² Associate Professor (Pharmaceutical Chemistry), Adesh Institute of Pharmacy and Biomedical Sciences, Adesh University, Bhatinda, Punjab, India³ Principal at Shrinathji Institute of Pharmacy, Nathdwara, Rajasthan, India

ABSTRACT

Synthesis of a series of various 2, 5-disubstituted-1, 3, 4-oxadiazole derivatives (7a-7u) have been done. Synthesis of a series of intermediates (3a-3c and 5a-5c) have been also done, ethyl-2-phenoxyacetate (3a), ethyl 2-(2, 4-dichlorophenoxy)acetate (3b), ethyl 2-(4-nitrophenoxy)acetate (3c), 2-phenoxyacetohydrazide (5a), 2-(2, 4-dichlorophenoxy)acetohydrazide (5b), 2-(4-nitrophenoxy)acetohydrazide (5c), and final product (7a-7u), 2-(phenoxyethyl)-5-phenyl-1, 3, 4-oxadiazole (7a), 4-(5-(phenoxyethyl)-1, 3, 4-oxadiazol-2-yl)aniline (7b), 3-(5-(phenoxyethyl)-1, 3, 4-oxadiazol-2-yl) aniline (7c), 2-(5-(phenoxyethyl)-1, 3, 4-oxadiazol-2-yl)phenol (7d), 2, 4-dinitro-6-(5-(phenoxyethyl)-1, 3, 4-oxadiazol-2-yl)phenol (7e), 2-(4-(methylthio)benzyl)-5-(phenoxyethyl)-1,3,4-oxadiazole (7f), 2-((2, 4-dichlorophenoxy) methyl)-5-phenyl-1,3,4-oxadiazole (7g), 4-(5-((2, 4-dichlorophenoxy) methyl)-1,3,4-oxadiazol-2-yl)aniline (7h), 3-(5-((2, 4-dichlorophenoxy) methyl)-1,3,4-oxadiazol-2-yl)aniline (7i), 2-(5-((2, 4-dichlorophenoxy) methyl)-1, 3, 4-oxadiazol-2-yl)phenol (7j), 2-(5-((2, 4-dichlorophenoxy) methyl)-1,3,4-oxadiazol-2-yl)-4,6-dinitrophenol (7k), 2-((2,4-dichlorophenoxy) methyl)-5-(4-(methylthio)benzyl)-1,3,4-oxadiazole (7l), (Z)-2-((2, 4-dichlorophenoxy) methyl)-5-styryl-1,3,4-oxadiazole (7m), (S)-4-(2-(5-((2,4-dichlorophenoxy) methyl)-1, 3, 4-oxadiazol-2-yl)propyl)phenol (7n), 2-((4-nitrophenoxy) methyl)-5-phenyl-1, 3, 4-oxadiazole (7o), 4-(5-((4-nitrophenoxy)methyl)-1,3,4-oxadiazol-2-yl)aniline (7p), 3-(5-((4-nitrophenoxy)methyl)-1,3,4-oxadiazol-2-yl)aniline (7q), 2-(5-((4-nitrophenoxy)methyl)-1,3,4-oxadiazol-2-yl)phenol (7r), 2, 4-dinitro-6-(5-((4-nitrophenoxy)methyl)-1,3,4-oxadiazol-2-yl)phenol (7s), 2-(4-(methylthio) benzyl)-5-((4-nitrophenoxy)methyl)-1,3,4-oxadiazole (7t), (Z)-2-((4-nitrophenoxy)methyl)-5-styryl-1,3,4-oxadiazole (7u) and 5-((2, 4-dichlorophenoxy)methyl)-1,3,4-oxadiazole-2-thiol (7v).

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*Address for Correspondence:

Neetesh Kumar Sharma, Associate Professor (Pharmaceutical Chemistry), Adesh Institute of Pharmacy and Biomedical Sciences, Adesh University, Bhatinda, Punjab, India

1. Introduction

Infection: An infection is the detrimental colonization of a host organism by a foreign species. In an infection, the infecting organism seeks to utilize the host's resources to multiply, usually at the expense of the host.¹

Anti-infectives: Agents that are designed to kill, or prevent the growth of microorganisms without serious toxicity to the host.²

Role of 1,3,4-Oxadiazole moiety in modern drug discovery.

A Wide variety of substituted 1,3,4-oxadiazoles have attracted considerable attention in the field of drug discovery because of their wide range of pharmacological activities. Oxadiazoles have occupied a specific place in the

field of medicinal chemistry due to its wide range of activities³.

1,3,4-oxadiazole derivatives show anticonvulsant⁴, antimicrobial activity⁵, insecticide⁶, anti-tubercular activity⁷, anti-inflammatory activity⁸, cardiovascular activity⁹, antialzheimers activity¹⁰, anti-tumor agents¹¹, antidiabetes¹² and spasmolytic activity¹³.

A series of various derivatives of final products 2-(phenoxyethyl)-5-phenyl-1, 3, 4-oxadiazole (7a), 4-(5-(phenoxyethyl)-1, 3, 4-oxadiazol-2-yl)aniline (7b), 3-(5-(phenoxyethyl)-1, 3, 4-oxadiazol-2-yl) aniline (7c), 2-(5-(phenoxyethyl)-1, 3, 4-oxadiazol-2-yl)phenol (7d), 2, 4-dinitro-6-(5-(phenoxyethyl)-1, 3, 4-oxadiazol-2-yl)phenol (7e), 2-(4-(methylthio)benzyl)-5-(phenoxyethyl)-1,3,4-oxadiazole (7f), 2-((2, 4-dichlorophenoxy) methyl)-5-phenyl-1,3,4-oxadiazole (7g), 4-(5-((2, 4-dichlorophenoxy)

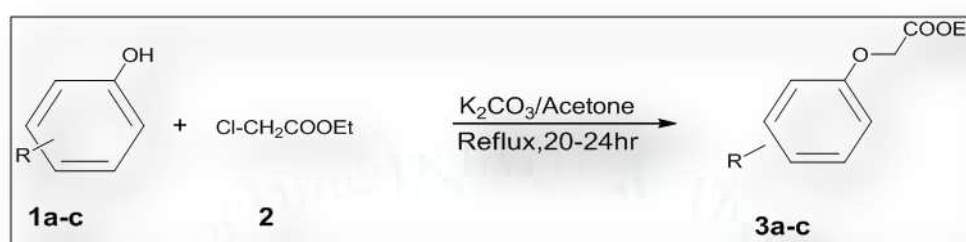
methyl)-1,3,4-oxadiazol-2-yl)aniline (7h), 3-(5-((2, 4-dichlorophenoxy) methyl)-1,3,4-oxadiazol-2-yl)aniline (7i), 2-(5-((2, 4-dichlorophenoxy) methyl)-1, 3, 4-oxadiazol-2-yl)phenol (7j), 2-(5-((2, 4-dichlorophenoxy) methyl)-1,3,4-oxadiazol-2-yl)-4,6-dinitrophenol (7k), 2-((2,4-dichlorophenoxy) methyl)-5-(4-(methylthio)benzyl)-1,3,4-oxadiazole (7l), (Z)-2-((2, 4-dichlorophenoxy) methyl)-5-styryl-1,3,4-oxadiazole (7m), (S)-4-(2-(5-((2,4-dichlorophenoxy) methyl)-1, 3, 4-oxadiazol-2-yl)propyl)phenol (7n), 2-((4-nitrophenoxy) methyl)-5-phenyl-1, 3, 4-oxadiazole (7o), 4-(5-((4-nitrophenoxy)methyl)-1,3,4-oxadiazol-2-yl)aniline (7p), 3-(5-((4-nitrophenoxy)methyl)-1,3,4-oxadiazol-2-yl)aniline (7q), 2-(5-((4-nitrophenoxy)methyl)-1,3,4-oxadiazol-2-yl)phenol (7r), 2, 4-dinitro-6-(5-((4-nitrophenoxy)methyl)-1,3,4-oxadiazol-2-yl)phenol (7s), 2-(4-(methylthio) benzyl)-5-((4-nitrophenoxy)methyl)-1,3,4-oxadiazole (7t), (Z)-2-((4-nitrophenoxy)methyl)-5-styryl-1,3,4-oxadiazole (7u) and 5-((2, 4-dichlorophenoxy)methyl)-1,3,4-oxadiazole-2-thiol

(7v) has been synthesized by a mixture of equimolar amounts of the substituted 2-phenoxyacetohydrazide and substituted aromatic acid were, contained in a round bottom flask and suspended in 5 ml phosphoryl trichloride. The mixture was refluxed on a sand bath with vigorous stirring. The reaction was monitored by TLC. The reaction was continued till the substituted 2-phenoxyacetohydrazide was consumed completely. Initially, the color of reaction mixture was color less in case of phenol while in other phenols light yellow and reaction proceeded till reaction mixture became dark in color.

All the compounds synthesized have been characterized by spectral data.

2. Experimental

2.1 General synthetic scheme for synthesis of substituted ethyl 2-phenoxyacetate (3a-3c)



Sr. No.	Compound	R
1	3a	-H
2	3b	Chloro group at position 1 and 4
3	3c	Nitro group at position 4

General Procedure:¹⁴

A mixture of equimolar amounts of the substituted phenol and ethylchloroacetate were, contained in a round bottom flask and suspended in 50-60 ml acetone and anhydrous potassium carbonate (1-2gm) was added in the mixture. The mixture was refluxed on a sand bath with vigorous stirring. The reaction was monitored by TLC. The reaction was continued till the substituted phenol was consumed completely. Initially, the colour of reaction mixture was color less in case of phenol while in other pheols light yellow and reaction proceeded till reaction mixture became dark in colour.

Workup: The reaction mixture, when cooled, was filtered under vaccum to remove solid potassium carbonate and the filtrate thus obtained was evaporated under vaccum. The residue thus obtained was dissolved into ethylacetate (10-15 ml) and washed with water twice. Ethylacetate layer was

separated and dried over anhydrous sodium sulphate. The solvent was evaporated under vaccum and the residue (liquid product) thus obtained was used for next step.

Yield % : 96.56% (3a), 92.53% (3b), 90.97% (3c)

TLC : Silica gel G; Hexane: Ethyl acetate (8:2)

R_f = 0.78 (3a), 0.79 (3b) and 0.56 (3c)

IR (Spectrum 1) of (3a): 3020.32, 1732.94, 1595.22, 1497.89, 1472.39, 1374.38, 1214.69, 1090.26, 1044.69, 746.68, 696.42, 666.72cm⁻¹

IR (Spectrum 2) of (3b): 3094.58, 3020.30, 2985.44, 1732.39, 1478.56, 1375.14, 1279.05, 1249.56, 1214.26, 1105.25, 1046.92, 929.20, 854.11, 744.60 cm⁻¹

IR (Spectrum 3) of (3c): 3062.74, 3019.59, 1749.28, 1716.97, 1592.05, 1338.83, 1213.97, 951.53, 848.51 cm⁻¹

2.2 General synthetic scheme for substituted 2-phenoxy acetohydrazide (5a-5c)

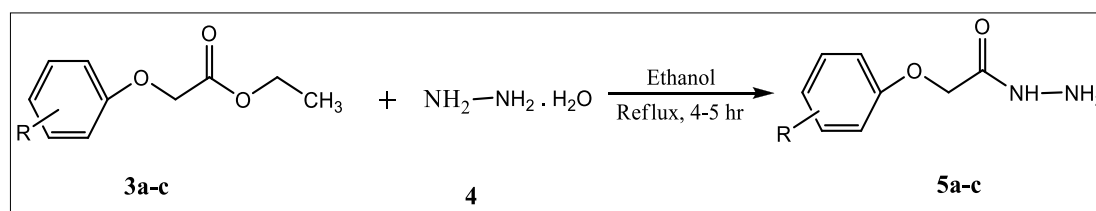


Figure 2:

Sr. No.	Compound	R
1	5a	-H
2	5b	Chloro group at position 1 and 4
3	5c	Nitro group at position 4

General Procedure:¹⁴

A solution of substituted ethyl 2-phenoxyacetate (1 mol) and hydrazine hydrate (1.5 mol) were contained in a round bottom flask and suspended in 50-60 ml ethanol. The mixture was refluxed for 5-6 hr on a sand bath with vigorous stirring. The reaction was monitored by TLC. The reaction was continued till the substituted ethyl 2-phenoxyacetate was consumed completely. Initially, the color of reaction mixture was colour less in case of phenol while in other phenols light yellow and reaction proceeded till reaction mixture became dark in colour.

Workup: The reaction mixture, when cooled, was filtered under vacuum to remove solid substituted 2-phenoxyacetohydrazide. The solid thus obtained was washed with ethanol, dried and used for next step.

Yield % : 96.87% (5a), 77.75% (5b) and 95.58% (5c)

Melting point : 100-105°C (5a), 150-155°C (5b) and 180-185°C (5c)

TLC : Silica gel G; Hexane: Ethyl acetate (1:1)

R_f = 0.34 (5a), 0.59 (5b) and 0.47 (5c)

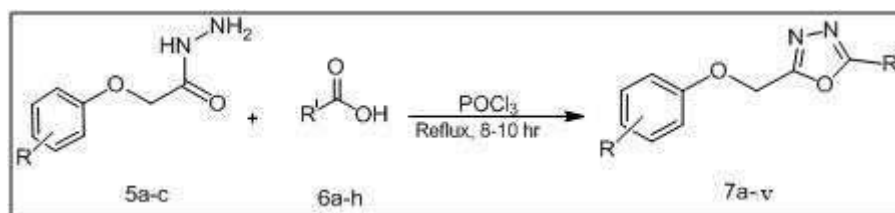
IR (Spectrum 4) of (5a): 3357.51, 3291.45, 3274.32, 2985.19, 1683.72, 1647.31, 1635.70, 1558.36, 1448.15, 1418.67, 1362.37, 1119.37, 951.16, 741.62 cm⁻¹

IR (Spectrum 5) of (5b): 3315.48, 3259.87, 3226.55, 3012.11, 1683.60, 1647.12, 1558.37, 1520.75, 1497.24, 1456.97, 1387.27, 1245.18, 1138.64, 1046.29, 791.81 cm⁻¹

IR (Spectrum 6) of (5c): 3290.42, 3117.25, 3011.92, 2946.03, 2868.98, 1653.19, 1540.35, 1490.22, 1418.99, 1334.62, 1267.14, 1112.39, 1001.04, 825.07, 749.67, 699.30 cm⁻¹

2.3 Synthesis of final products (7a-7v)

General scheme



Sr. No.	Compound	R	R'
1	7a	-H	-C ₆ H ₅
2	7b	-H	4-NH ₂ C ₆ H ₅ -
3	7c	-H	3-NH ₂ C ₆ H ₅ -
4	7d	-H	2-OHC ₆ H ₅ -
5	7e	-H	2-OH-3,5-dinitroC ₆ H ₅ -
6	7f	-H	1-CH ₂ -4-SCH ₃ C ₆ H ₅ -
7	7g	Chloro at position 2 and 4	-C ₆ H ₅
8	7h	Chloro at position 2 and 4	4-NH ₂ C ₆ H ₅ -
9	7i	Chloro at position 2 and 4	3-NH ₂ C ₆ H ₅ -
10	7j	Chloro at position 2 and 4	2-OHC ₆ H ₅ -
11	7k	Chloro at position 2 and 4	2-OH-3,5-dinitroC ₆ H ₅ -
12	7l	Chloro at position 2 and 4	1-CH ₂ -4-SCH ₃ C ₆ H ₅ -
13	7m	Chloro at position 2 and 4	C ₆ H ₅ CH=CH-
14	7n	Chloro at position 2 and 4	4-OHC ₆ H ₅ CH ₂ (NH ₂)-
15	7o	Nitro group at position 4	-C ₆ H ₅
16	7p	Nitro group at position 4	4-NH ₂ C ₆ H ₅ -
17	7q	Nitro group at position 4	3-NH ₂ C ₆ H ₅ -
18	7r	Nitro group at position 4	2-OHC ₆ H ₅ -
19	7s	Nitro group at position 4	2-OH-3,5-dinitroC ₆ H ₅ -
20	7t	Nitro group at position 4	1-CH ₂ -4-SCH ₃ C ₆ H ₅ -
21	7u	Nitro group at position 4	C ₆ H ₅ CH=CH-
22	7v	Chloro at position 2 and 4	-SH

Sr. No.	Compound	PercentageYield	Melting Point	R _f Value
	7a	78.95	95-100°C	0.78
	7b	90.68	135-140°C	0.75
	7c	89.44	155-160°C	0.66
	7d	90.06	120-125°C	0.87
	7e	91.66	105-110°C	0.70
	7f	87.76	125-130°C	0.76
	7g	85.29	115-120°C	0.69
	7h	88.11	>250°C	0.75
	7i	78.32	>250°C	0.75
	7j	90.21	>250°C	0.75
	7k	90.66	110-115°C	0.75
	7l	79.63	>250°C	0.84
	7m	97.30	>250°C	0.72
	7n	78.39	140-145°C	0.74
	7o	90.78	150-155°C	0.78
	7p	89.19	100-105°C	0.44
	7q	93.22	120-125°C	0.44
	7r	91.89	>250°C	0.84
	7s	92.67	>250°C	0.47
	7t	92.90	>250°C	0.31
	7u	94.12	>250°C	0.75
	7v	88.98	120-125°C	0.78

Experimental Data

IR (Spectrum 7) of (7a): 3011.86, 2977.55, 2966.99, 1635.48, 1597.58, 1556.61, 1436.47, 1237.48, 1175.15, 973.13, 771.21, 752.61 cm^{-1}

IR (Spectrum 8) of (7b): 3066.88, 3033.69, 2977.96, 1662.08, 1540.49, 1496.42, 1172.78, 995.29, 896.02, 828.55 cm^{-1}

IR (Spectrum 9) of (7c): 3110.94, 3077.17, 3020.98, 1669.60, 1615.92, 1418.10, 1317.71, 1219.69, 1090.33, 772.61 cm^{-1}

IR (Spectrum 10) of (7d): 3067.99, 3012.03, 2948.61, 2890.45, 1652.29, 1540.77, 1456.56, 1219.55, 772.51, 688.50 cm^{-1}

IR (Spectrum 11) of (7e): 3088.73, 3055.12, 3021.90, 1598.93, 1540.10, 1489.26, 1338.88, 1219.60, 855.69, 772.46 cm^{-1}

IR (Spectrum 12) of (7f): 2946.08, 2838.51, 1698.90, 1635.69, 1496.90, 1473.30, 1362.27, 1216.53, 1136.47, 843.65 cm^{-1}

IR (Spectrum 13) of (7g): 3094.58, 3020.30, 2985.44, 1732, 1478, 1375, 1279, 1249, 1105, 929, 854, 744 cm^{-1}

IR (Spectrum 14) of (7h): 3344.56, 3274.44, 3024.34, 2922.61, 1647.19, 1558.52, 1558.52, 1473.93, 1156.29, 951.89, 798.86 cm^{-1}

IR (Spectrum 15) of (7i): 334.31, 3139.63, 1558.60, 1520.61, 1464.99, 1295.24, 1204.84, 756.31 cm^{-1}

IR (Spectrum 16) of (7j): 3336.78, 2925.45, 2854.17, 1652.45, 1624.40, 1540.76, 1474.58, 1435.42, 1388.64, 1289.03, 1212.89, 1157.69, 1102.84, 1072.37, 799.08 cm^{-1}

IR (Spectrum 17) of (7k): 3087.57, 2921.42, 2872.32, 2839.16, 1652.87, 1558.45, 1540.74, 1464.77, 1339.21, 1219.56, 883.79, 772.31, 729.42 cm^{-1}

IR (Spectrum 18) of (7l): 3177.48, 3022.63, 2900.55, 1601.85, 1525.74, 1474.15, 1391.16, 1226.00, 991.53, 870.75, 793.81, 763.13 cm^{-1}

IR (Spectrum 19) of (7m): 2975.41, 2932.90, 1683.87, 1647.21, 1558.45, 1533.57, 1507.23, 1448.15, 1219.86, 773.05 cm^{-1}

IR (Spectrum 20) of (7n): 3446.78, 3013.35, 2976.92, 2938.40, 1662.62, 1635.81, 1558.45, 1507.23, 1473.54, 1219.90, 1084.93, 771.72 cm^{-1}

IR (Spectrum 21) of (7o): 3065.81, 3003.83, 2946.86, 1698.96, 1669.97, 1647.22, 1558.41, 1520.83, 1473.33, 1087.92, 940.84, 689.52 cm^{-1}

IR (Spectrum 22) of (7p): 3333.63, 3295.67, 3136.42, 2907.44, 1635.61, 1591.39, 1508.27, 1340.76, 1251.21, 1175.91, 1111.09, 844.68, 749.56 cm^{-1}

IR (Spectrum 23) of (7q): 3296.10, 3241.23, 3110.94, 3077.03, 1590.12, 1507.54, 1435.99, 1339.53, 1250.66, 843.50, 797.27 cm^{-1}

IR (Spectrum 24) of (7r): 3054.50, 2977.28, 2908.40, 1516.22, 1340.38, 1251.29, 1220.74, 1064.25, 845.02, 772.63 cm^{-1}

IR (Spectrum 25) of (7s): 3024.44, 2984.84, 1621.48, 1539.88, 1456.63, 1374.18, 1339.92, 1286.23, 1063.36, 865.57, 772.36 cm^{-1}

IR (Spectrum 26) of (7t): 3039.38, 2992.33, 1652.36, 1623.35, 1558.08, 1475.23, 1220.67, 1129.95, 979.82, 867.41, 772.58 cm^{-1}

IR (Spectrum 27) of (7u): 3088.29, 3054.22, 2992.16, 1557.96, 1519.00, 1489.19, 1339.19, 1258.85, 1112.13, 844.76 cm^{-1}

IR (Spectrum 28) of (7v): 3229.10, 3013.16, 2946.86, 1698.96, 1669.97, 1647.22, 1558.41, 1520.83, 1473.33, 1087.92, 940.84, 689.52

3. Result and Discussion**3.1 Characterization of Intermediate (3a-3c)**

IR: The spectrum showed characteristic ester band in the range 1749-1720 cm^{-1} and C-Cl stretching peak at in the range of 750-780 cm^{-1} . The -OH stretching peak corresponding to the phenol in the range of 3450-3400 cm^{-1} was disappeared thus confirming formation of the desired intermediate. Also, the values are in agreement with those reported ethyl 2-phenoxyacetate.¹⁵

3.2 Characterization of Intermediate (5a-5c)

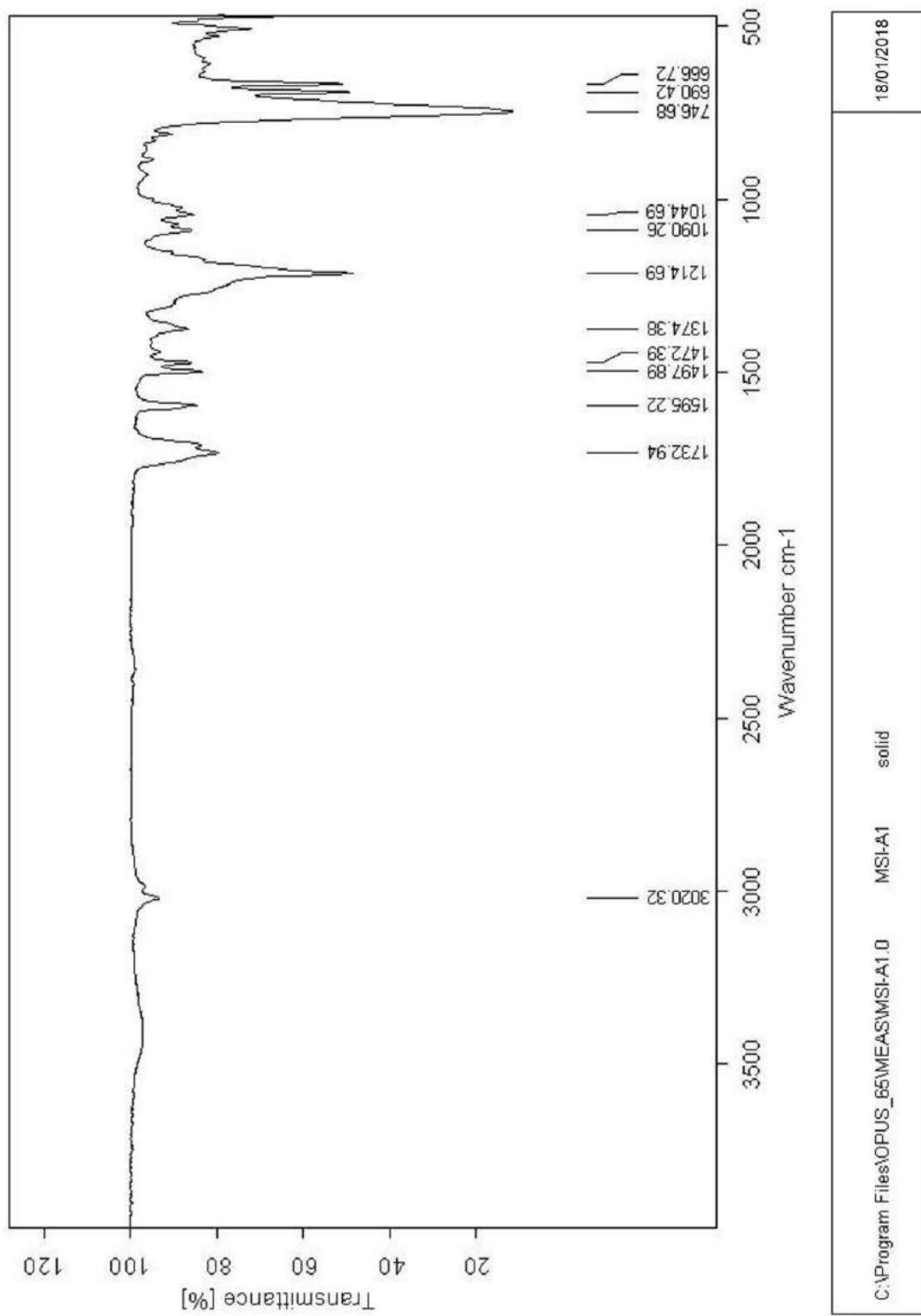
The spectrum showed characteristic hydrazide band in the range of 1640-1670 cm^{-1} and the stretching peak corresponding to the ester in the range of 1725-11745 cm^{-1} was disappeared. N-H stretching band of -NH-NH₂ group appeared in the range of 3325-3100 cm^{-1} . That it confirm the formation of the desired intermediate. Also, the values are in agreement with the reported 2-phenoxyacetohydrazide.¹⁵

3.3 Characterization of 2, 5-disubstituted -1,3,4-oxadiazole (7a-7u)

IR: The spectrum showed characteristic absorption band accordingly of the presence of functional group. The Ar-C-H stretching showed the absorption band in the range of 3020-3050 cm^{-1} . The -C=N stretching band appeared in the range of 1630-1660 cm^{-1} , -C=C- stretching peak comes in the range of 1400-1500 cm^{-1} , alkyl C-H stretching peak comes in the range of 2800-2900 cm^{-1} . Arylether stretching band appeared in the range of 1100-1200 cm^{-1} . Compounds **7b**, **7c**, **7h**, **7i**, **7n**, **7p** and **7q** contain aromatic -NH₂, which showed N-H stretching band in the range of 3150-3300 cm^{-1}

3.4 Characterization of 5-((2,4-dichlorophenoxy)methyl)-1,3,4-oxadiazole thiol (7v)

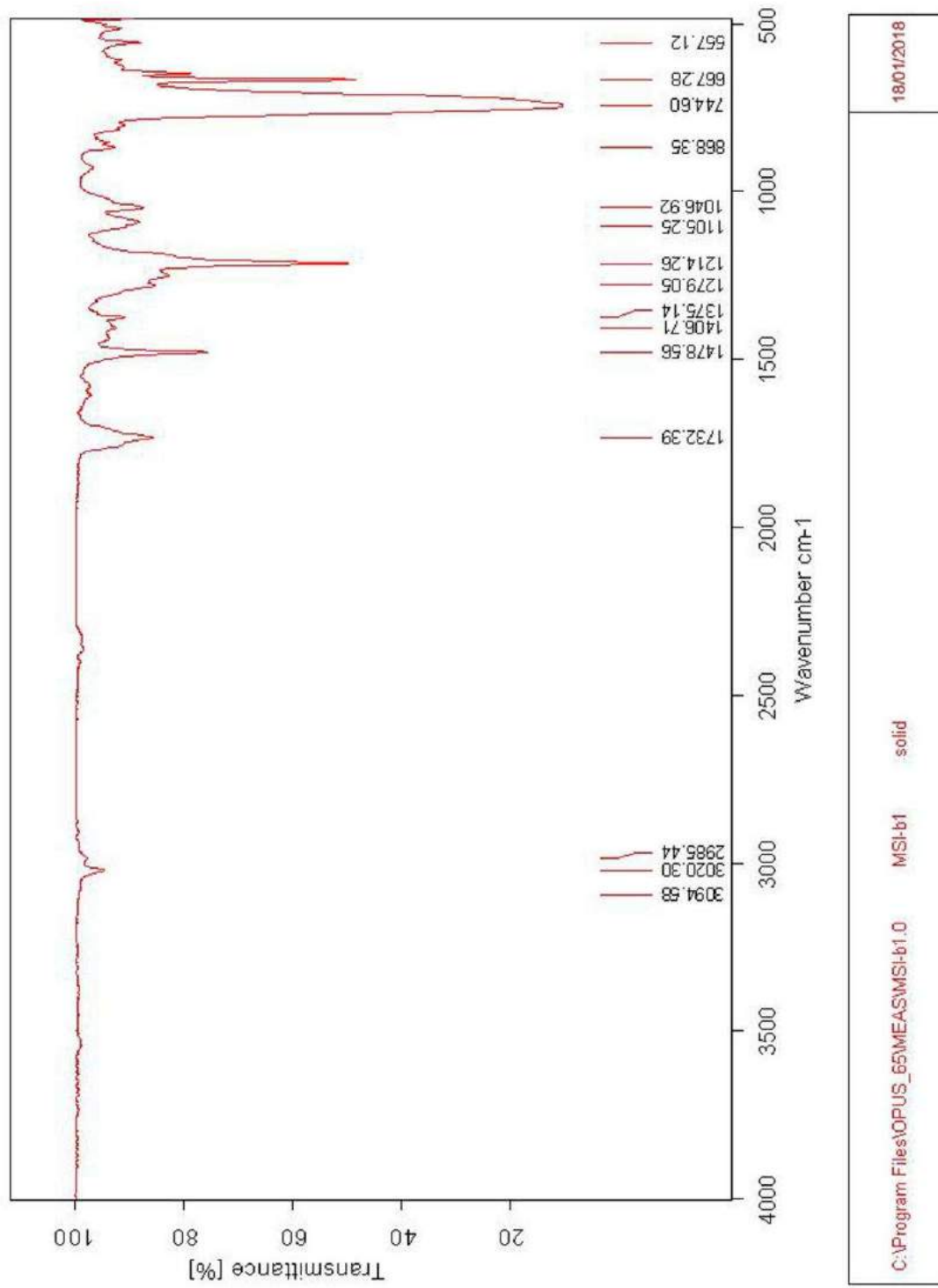
IR: In the solid state, the thiol (SH) form of the oxadiazole predominated the tautomeric thione (C=S). The characteristic SH stretching peak was seen 2550-2590 cm^{-1} .¹⁵



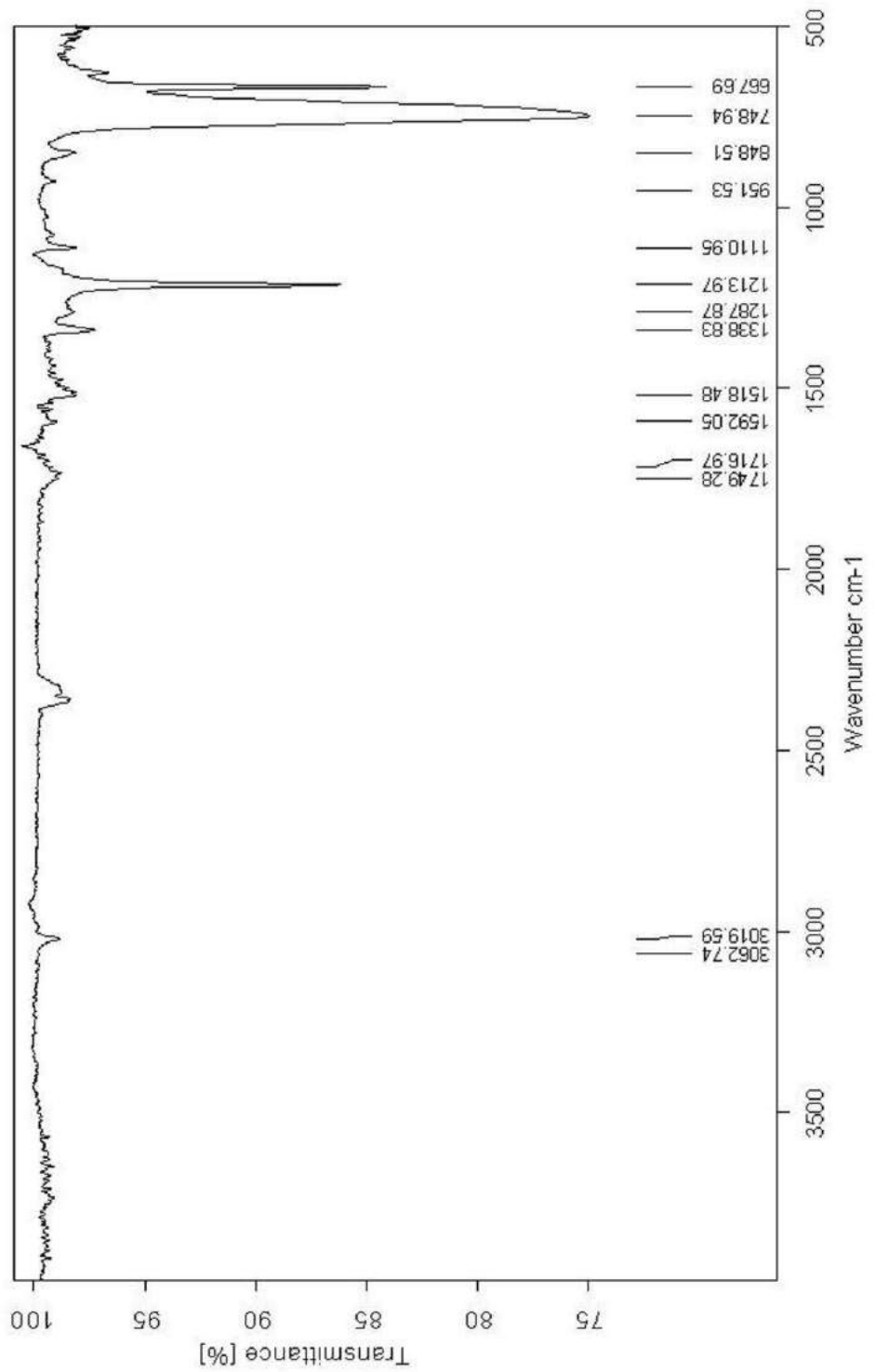
Spectrum 1: IR Spectrometer of intermediate 3a

18/01/2018

C:\Program Files\OPUS_65\MEAS\MST-A1.D MST-A1 solid

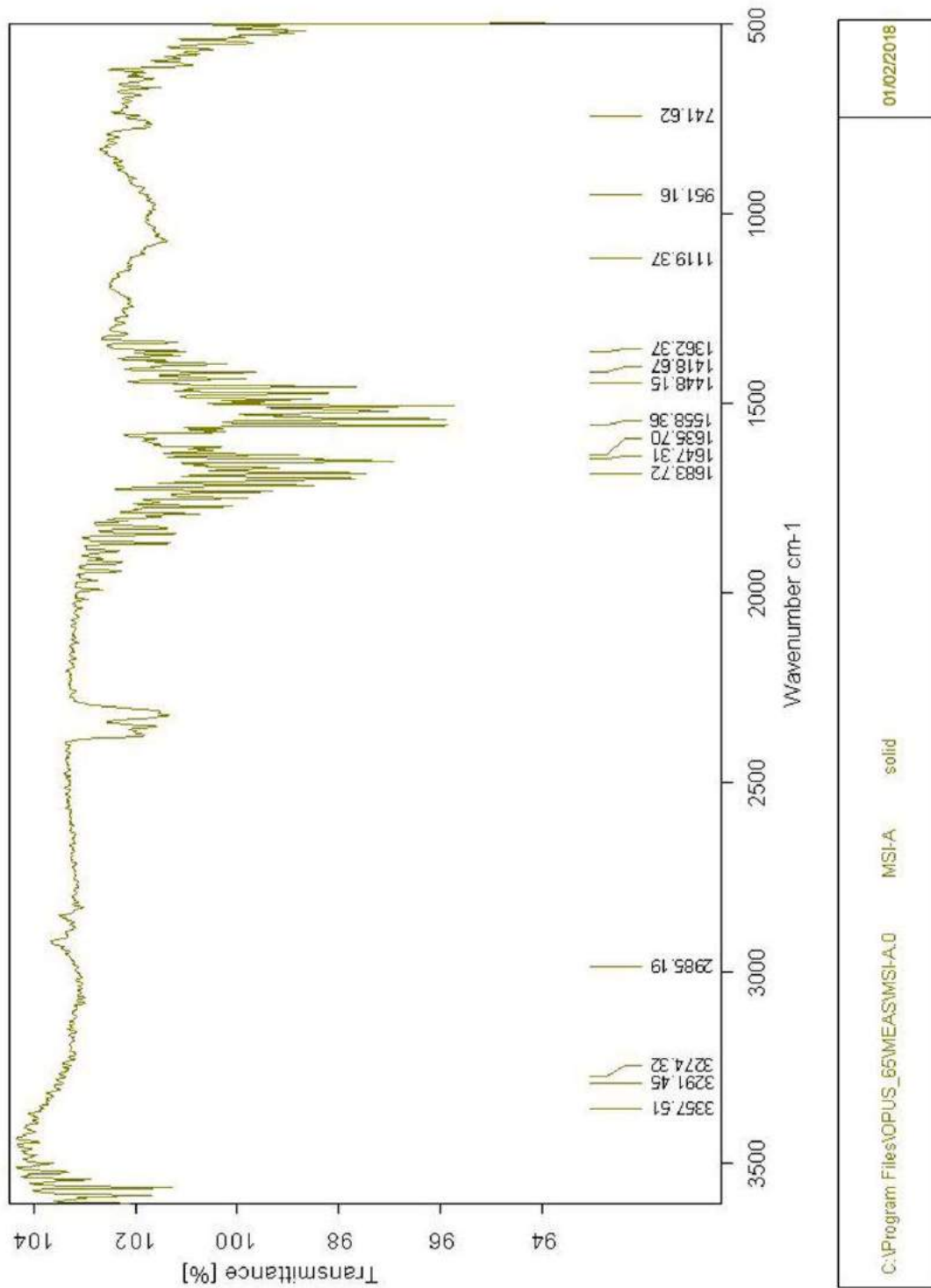


Spectrum 2: IR Spectrometer of intermediate 3b

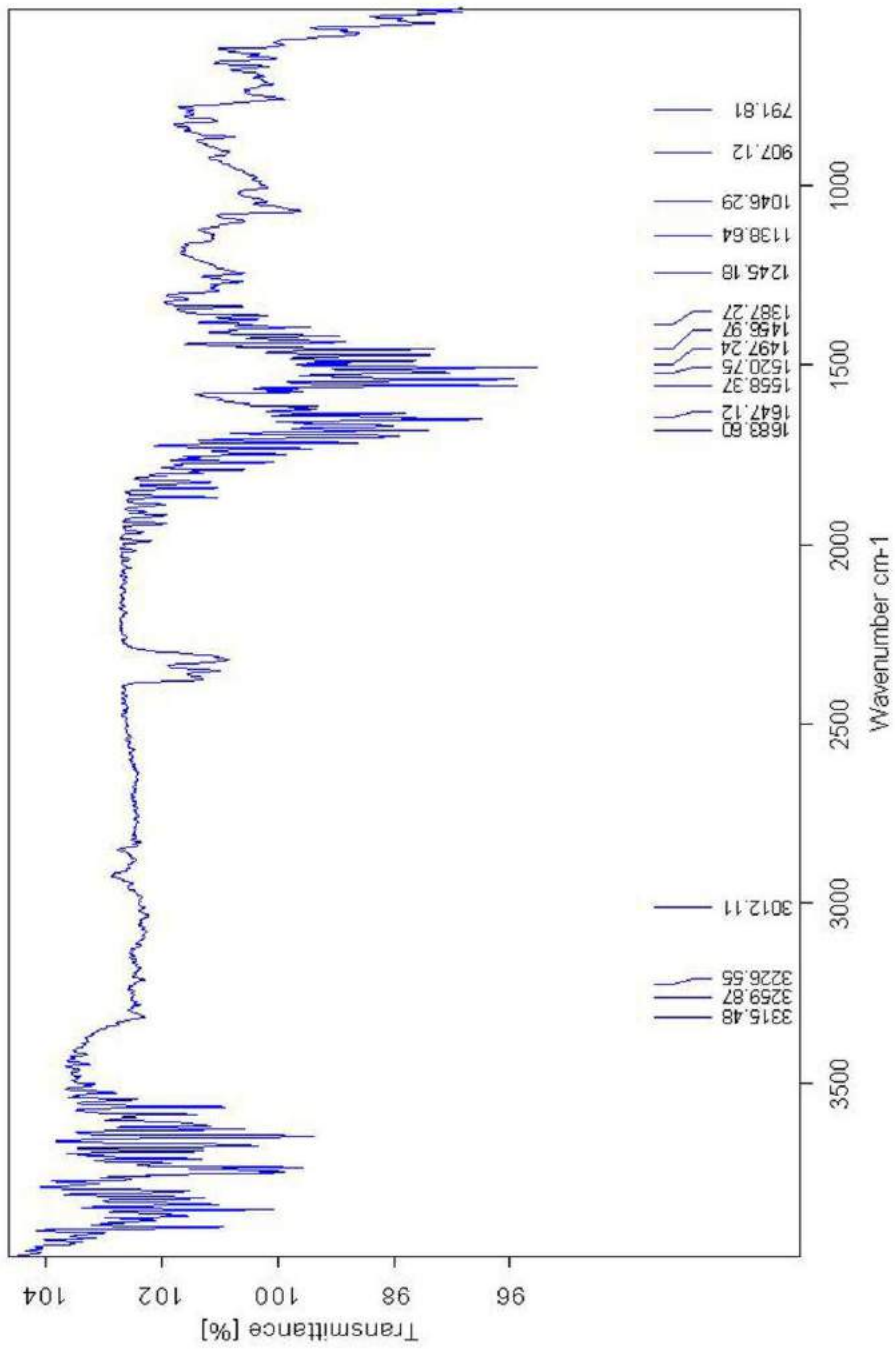


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Spectrum 3: IR Spectrometer of intermediate 3c

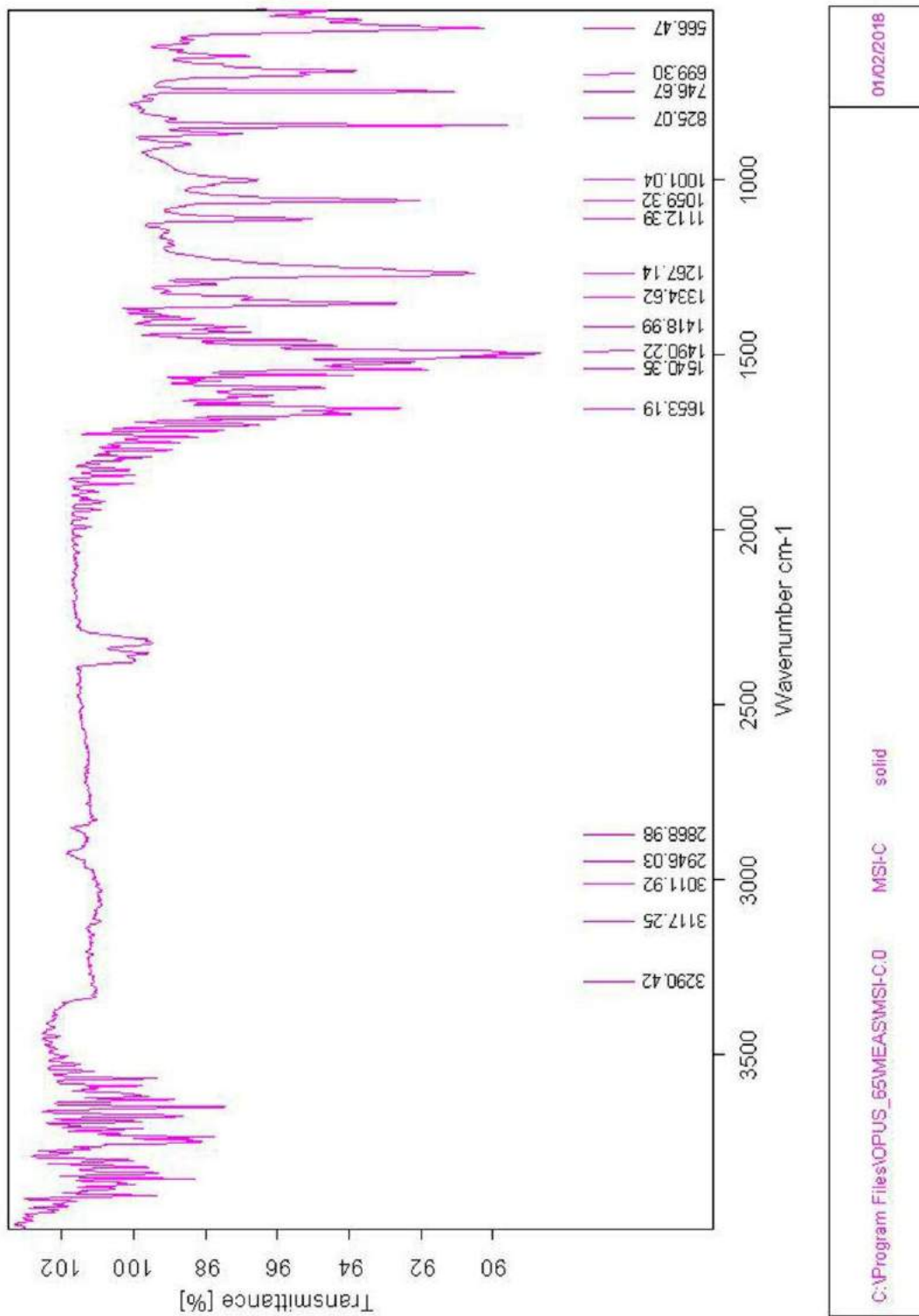


Spectrum 4: IR Spectrometer of intermediate 5a

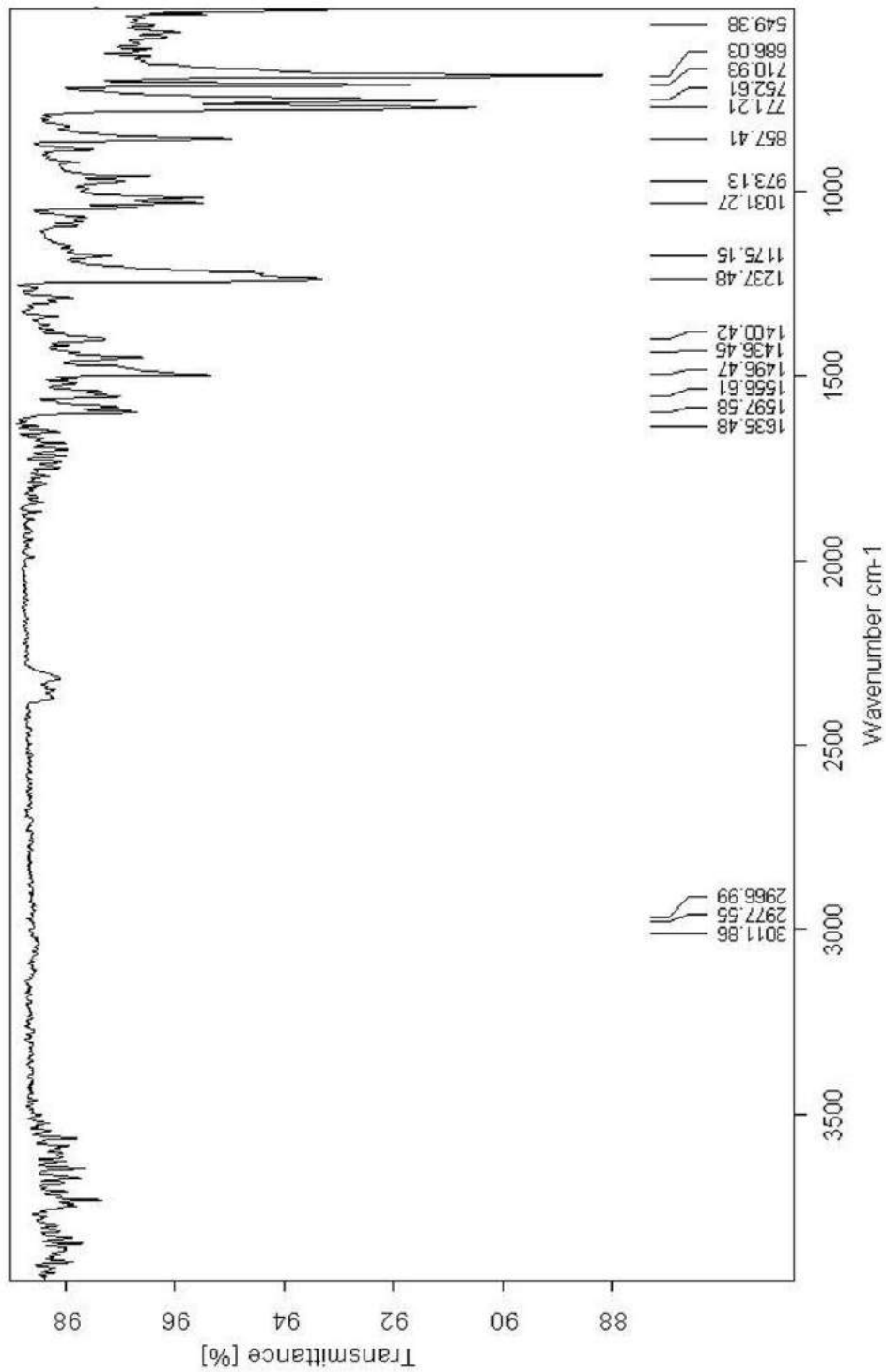


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Spectrum 5: IR Spectrometer of intermediate 5b

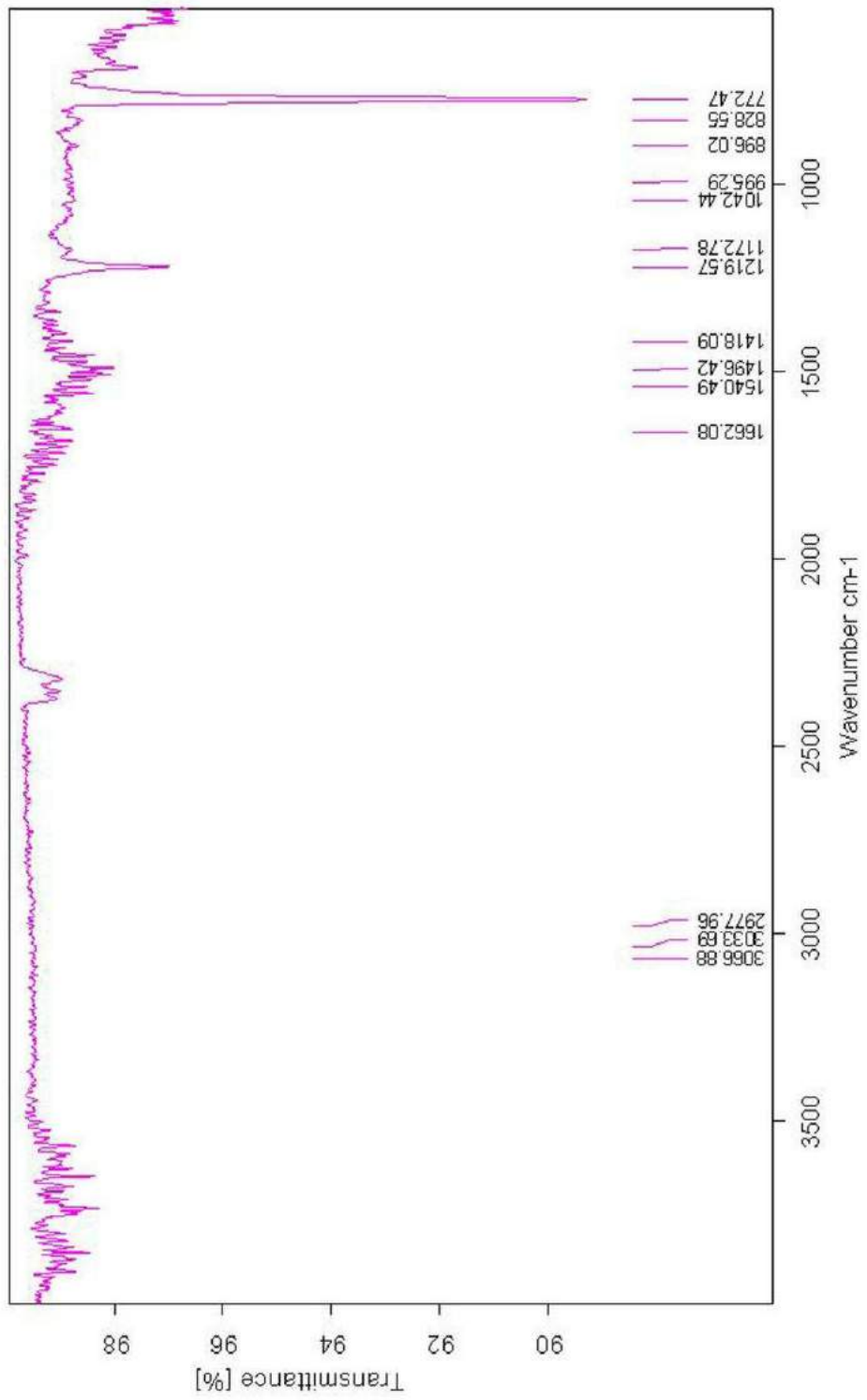


Spectrum 6: IR. Spectrometer of intermediate 5c



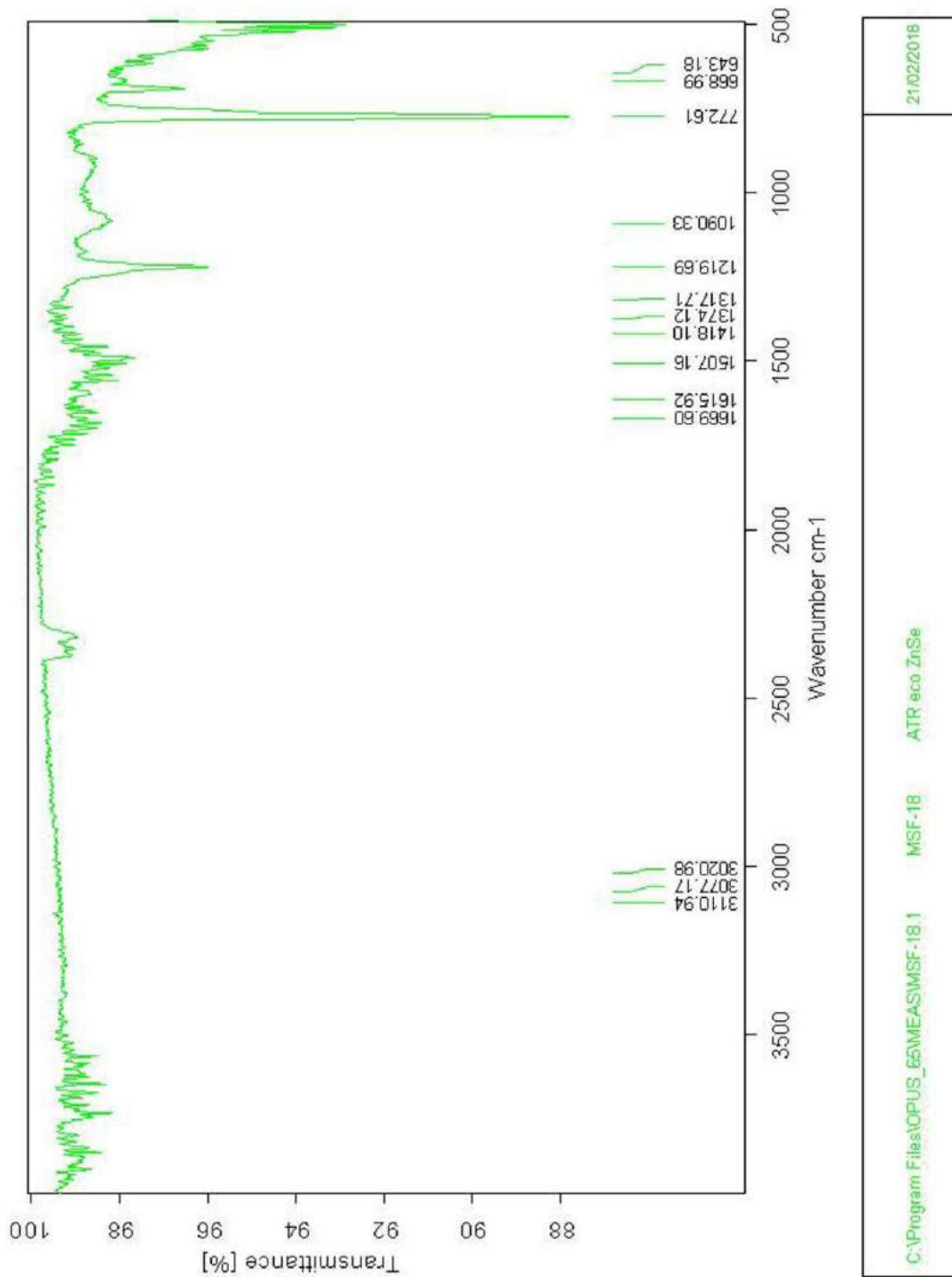
C:\Program Files\OPUS_65\MEAS\MSF-16.1 MSF-16 ATR eco ZnSe 21/02/2018

Spectrum 7: IR. Spectrometer of synthesized compound 7a

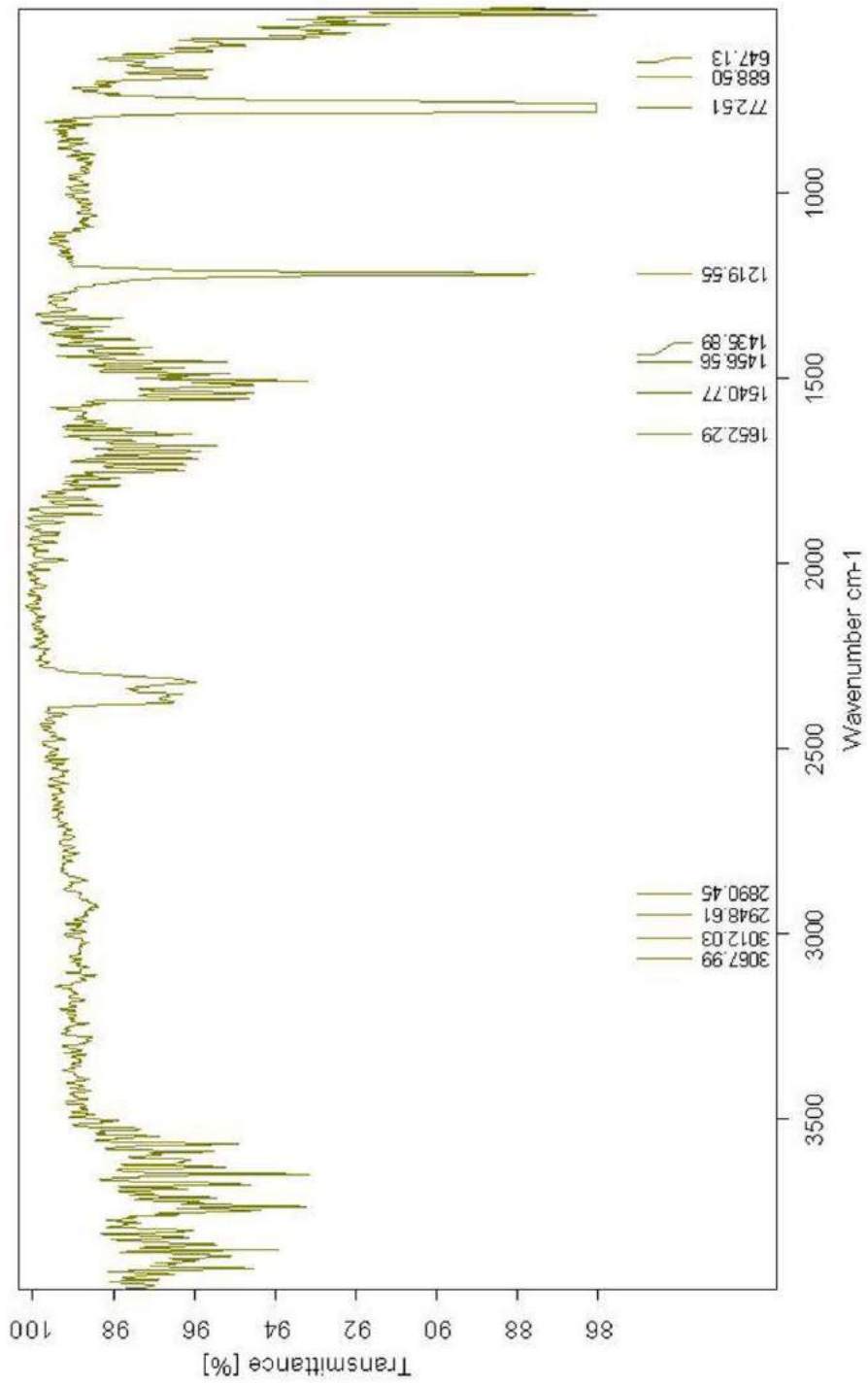


C:\Program Files\OPUS_65\MEAS\MSF-17.1 MSF-17 ATR eco ZnSe 21/02/2018

Spectrum 8: IR Spectrometer of synthesized compound 7b

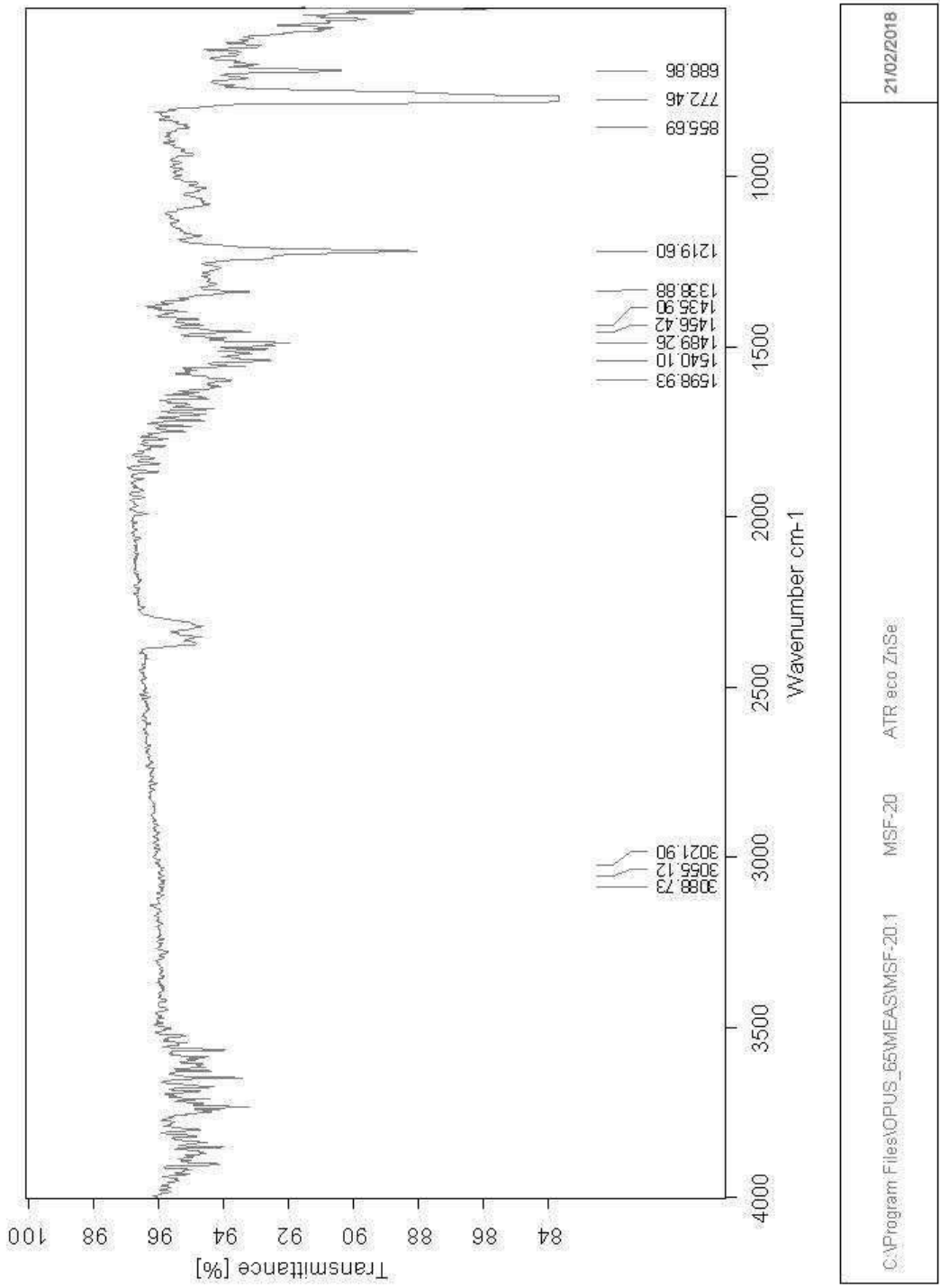


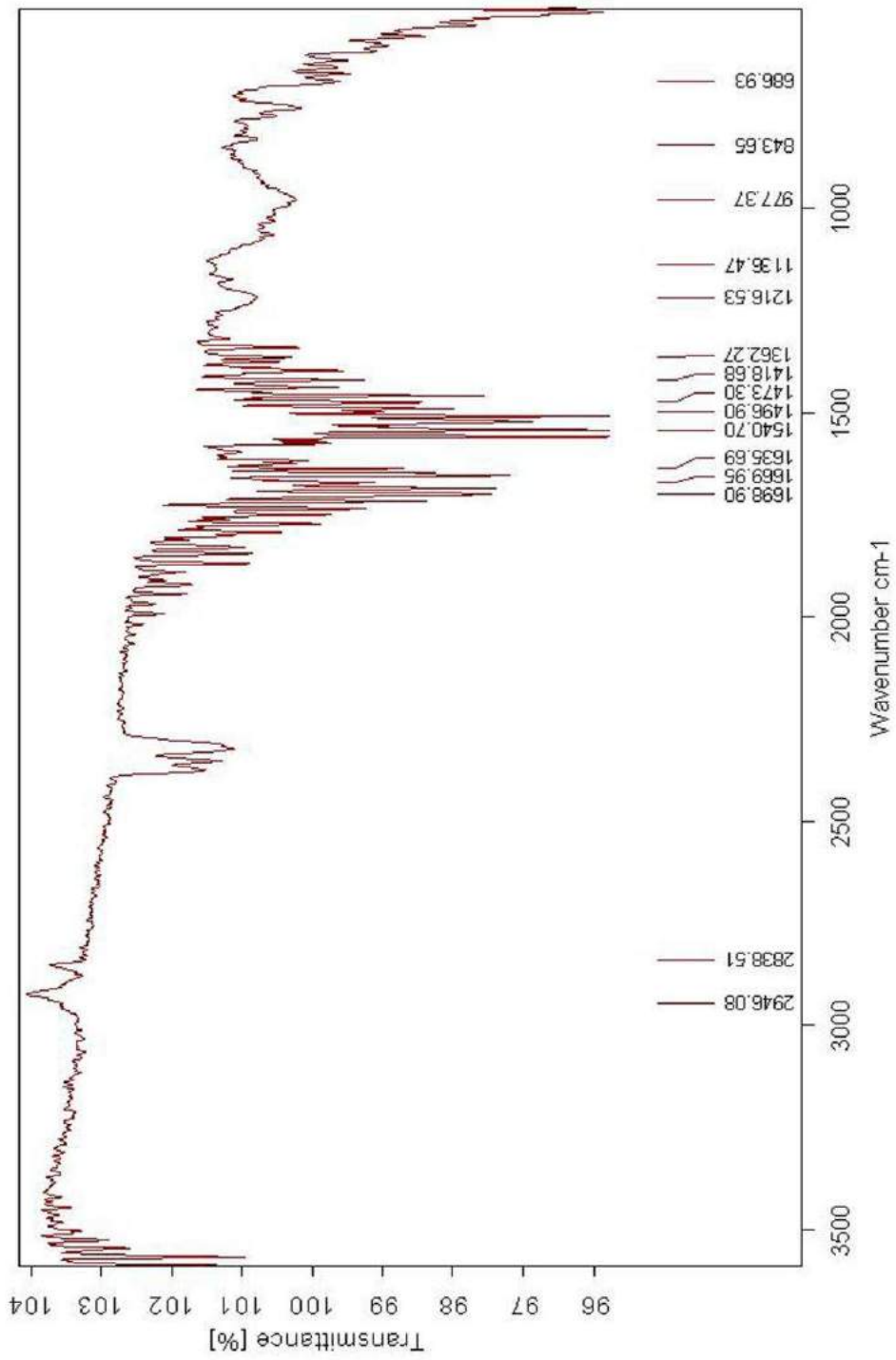
Spectrum 9: IR Spectrometer of synthesized compound 7c



C:\Program Files\OPUS_65\MEAS\MSF-19.2 MSF-19 ATR eco ZnSe 21/02/2018

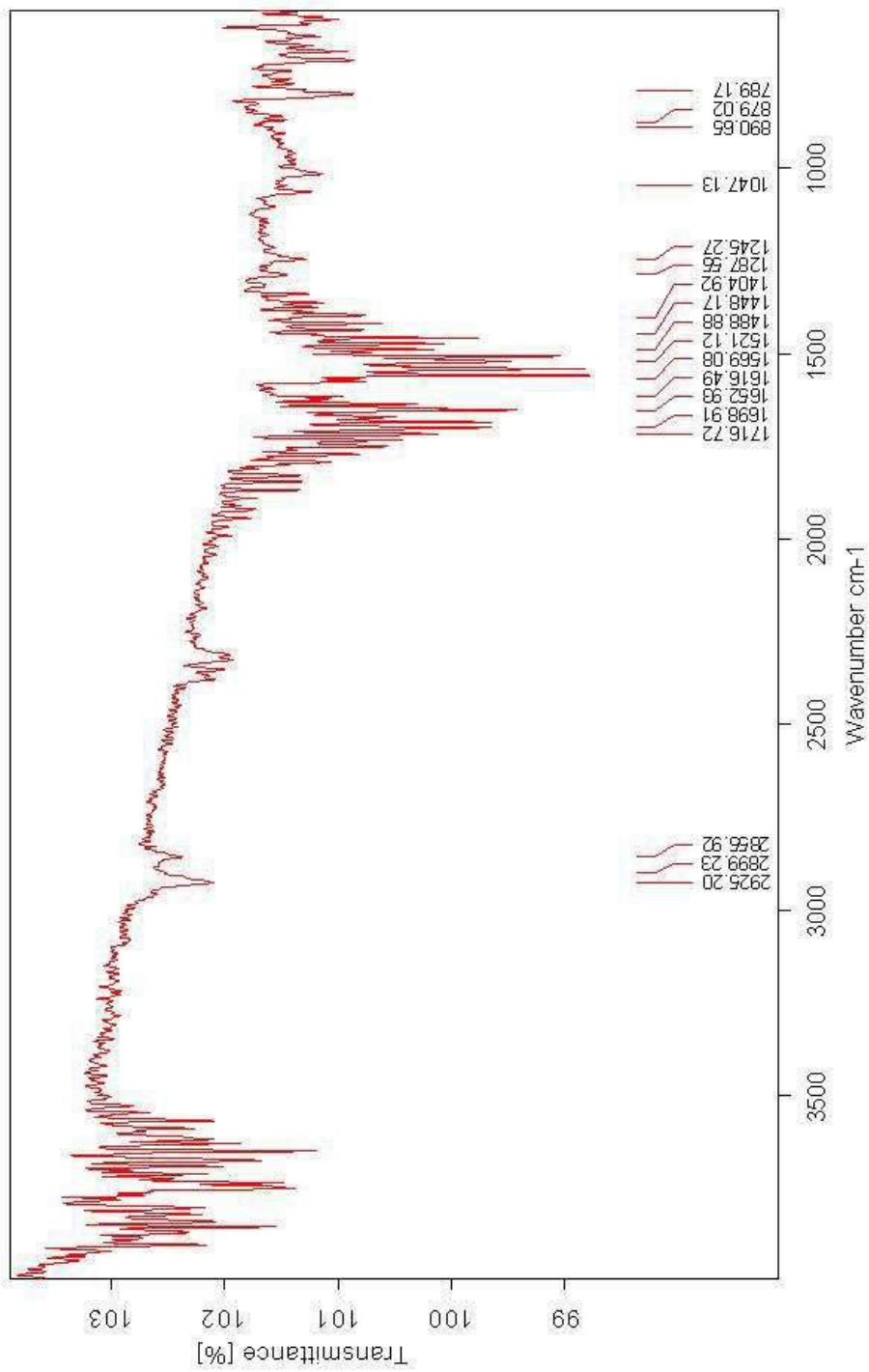
Spectrum 10: IR Spectrometer of synthesized compound 7d





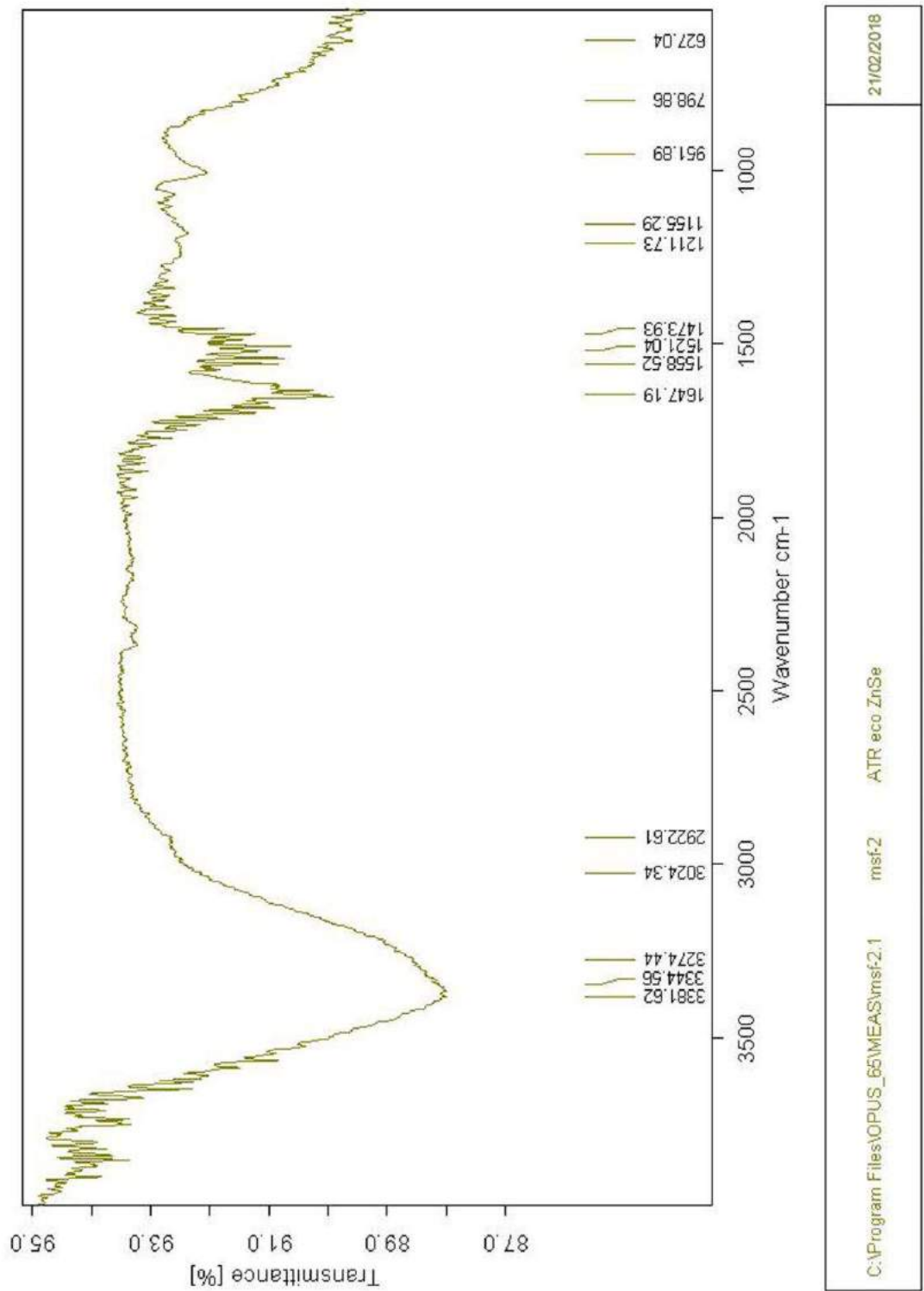
C:\Program Files\OPUS_65\MEAS\MSF-21.0 MSF-21 solid 21/02/2018

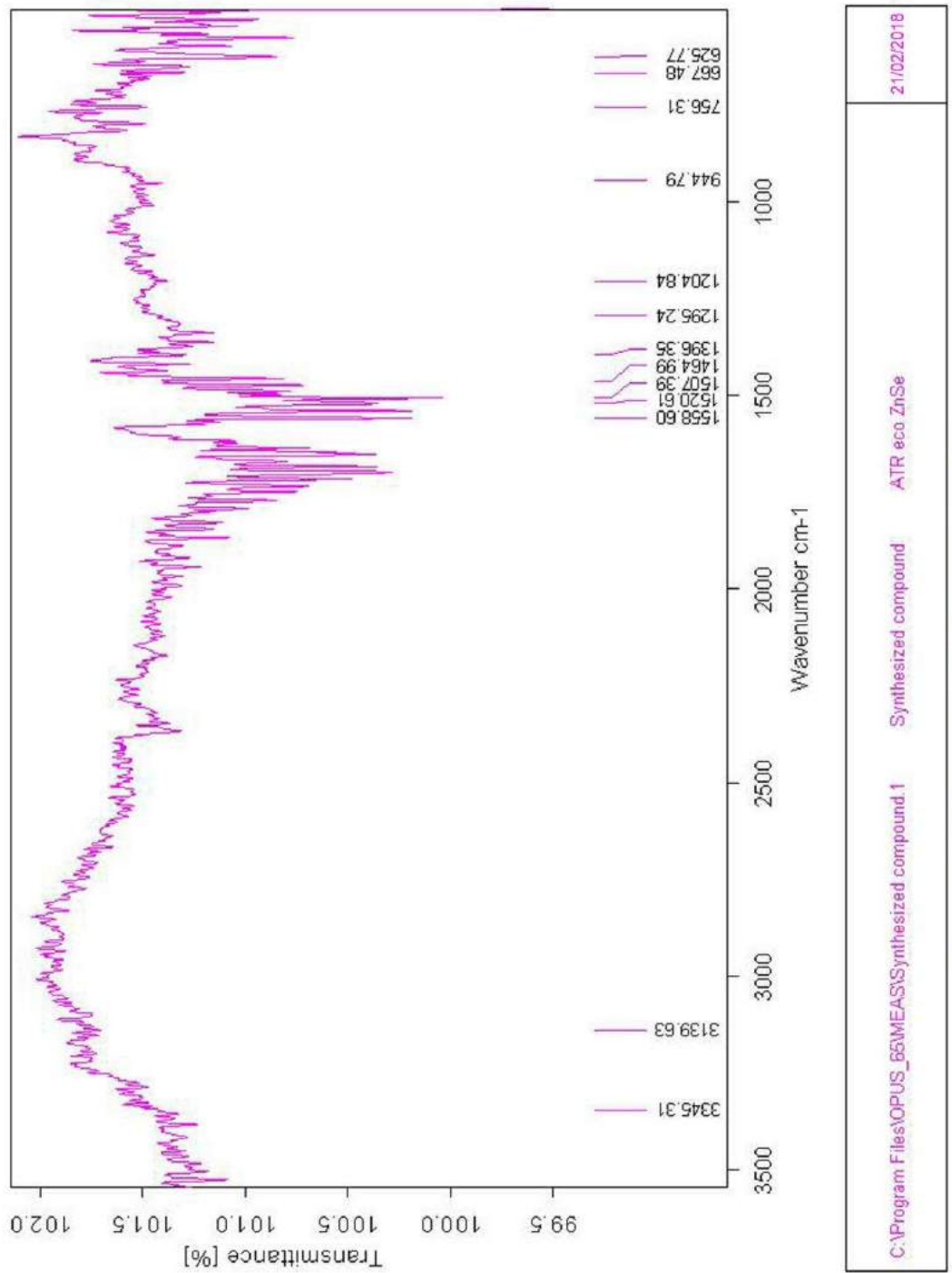
Spectrum 12: IR Spectrometer of synthesized compound 7f



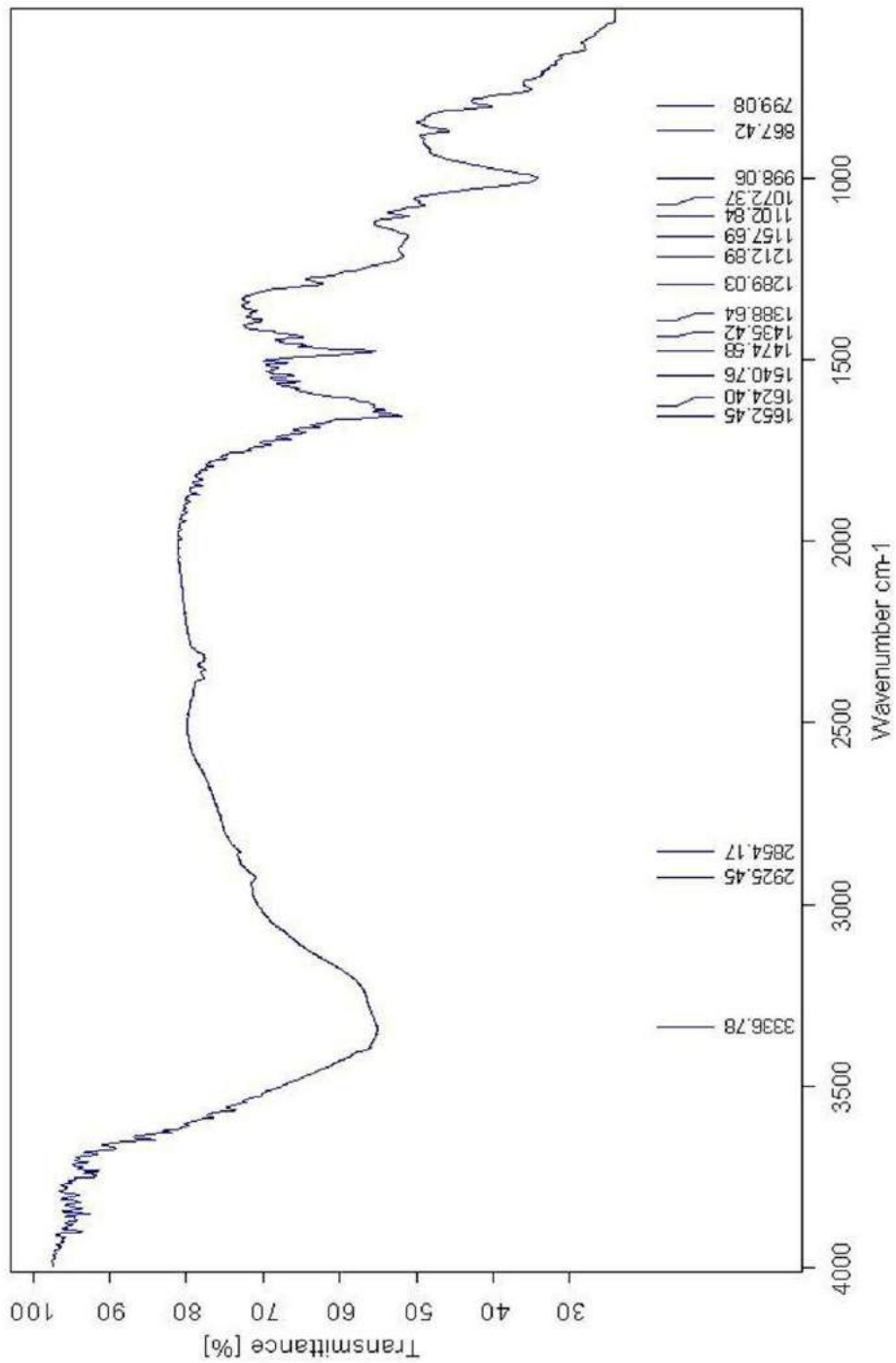
C:\Program Files\OPUS_65\MEAS\MSF-1.0 IMSF-1 solid 21/02/2018

Spectrum 13: IR Spectrometer of synthesized compound 7g



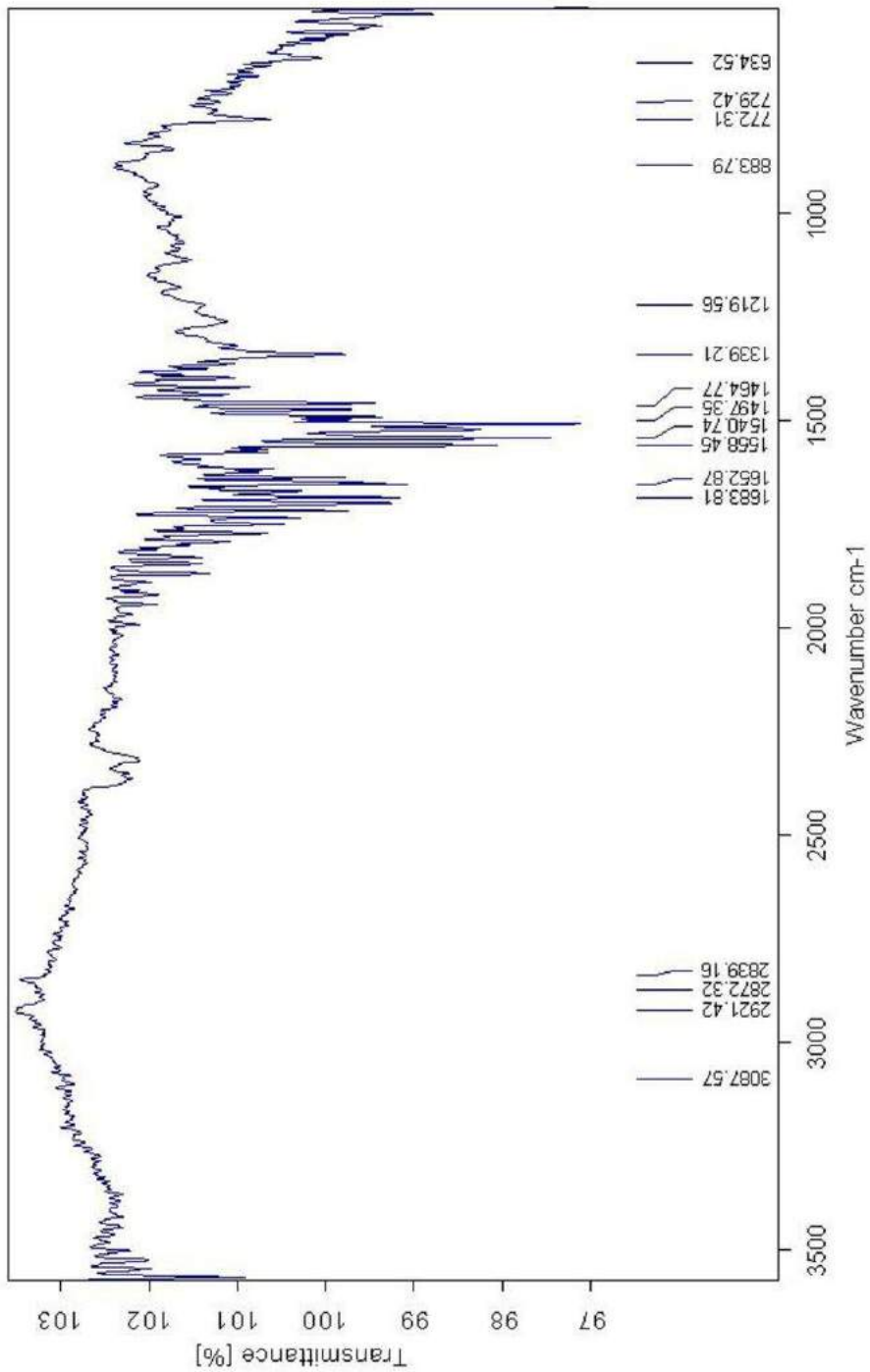


Spectrum 15: IR Spectrometer of synthesized compound 7i



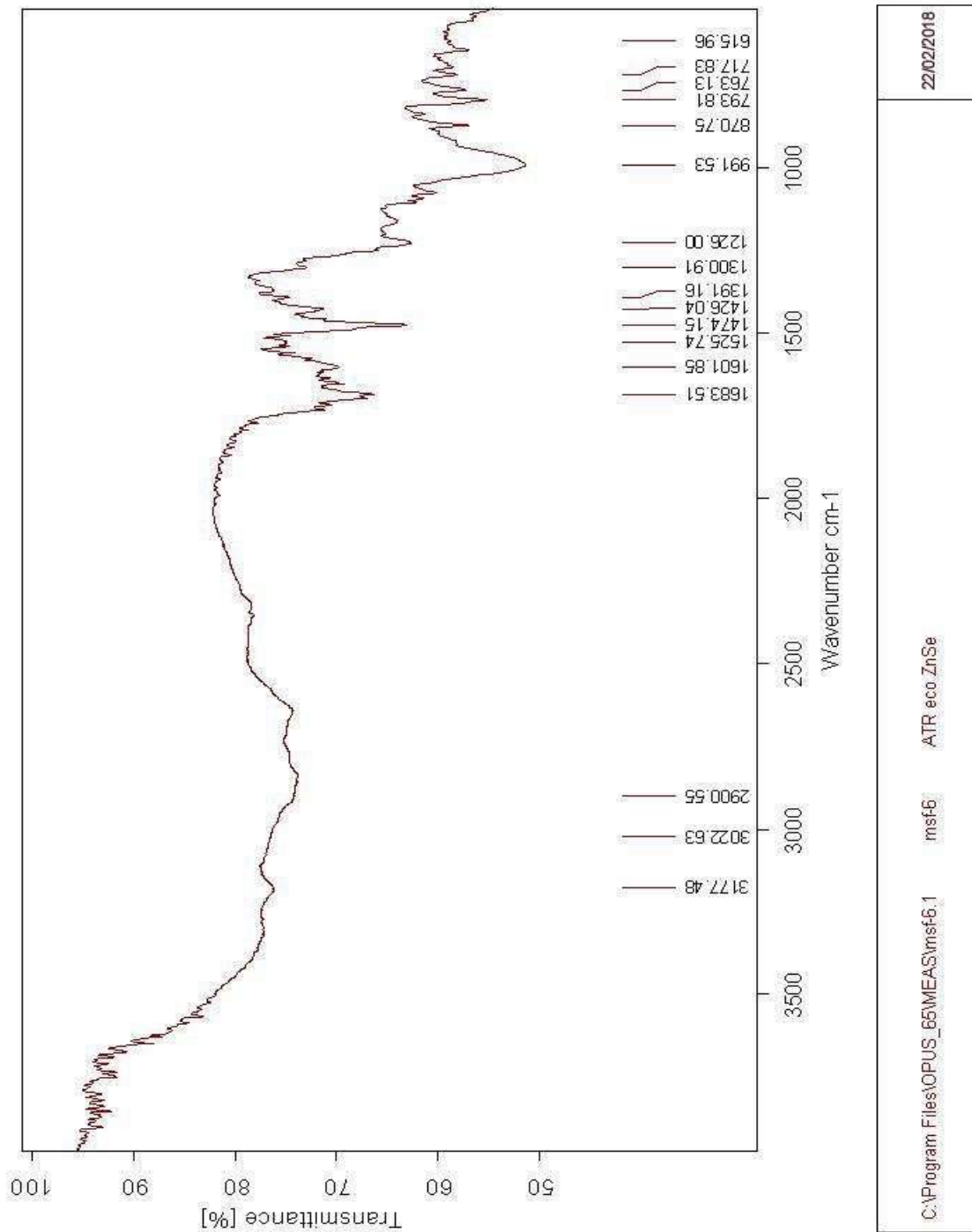
C:\Program Files\OPUS_65\MEAS\MSF-4.0 MSF-4 solid 21/02/2018

Spectrum 16: IR Spectrometer of synthesized compound 7j

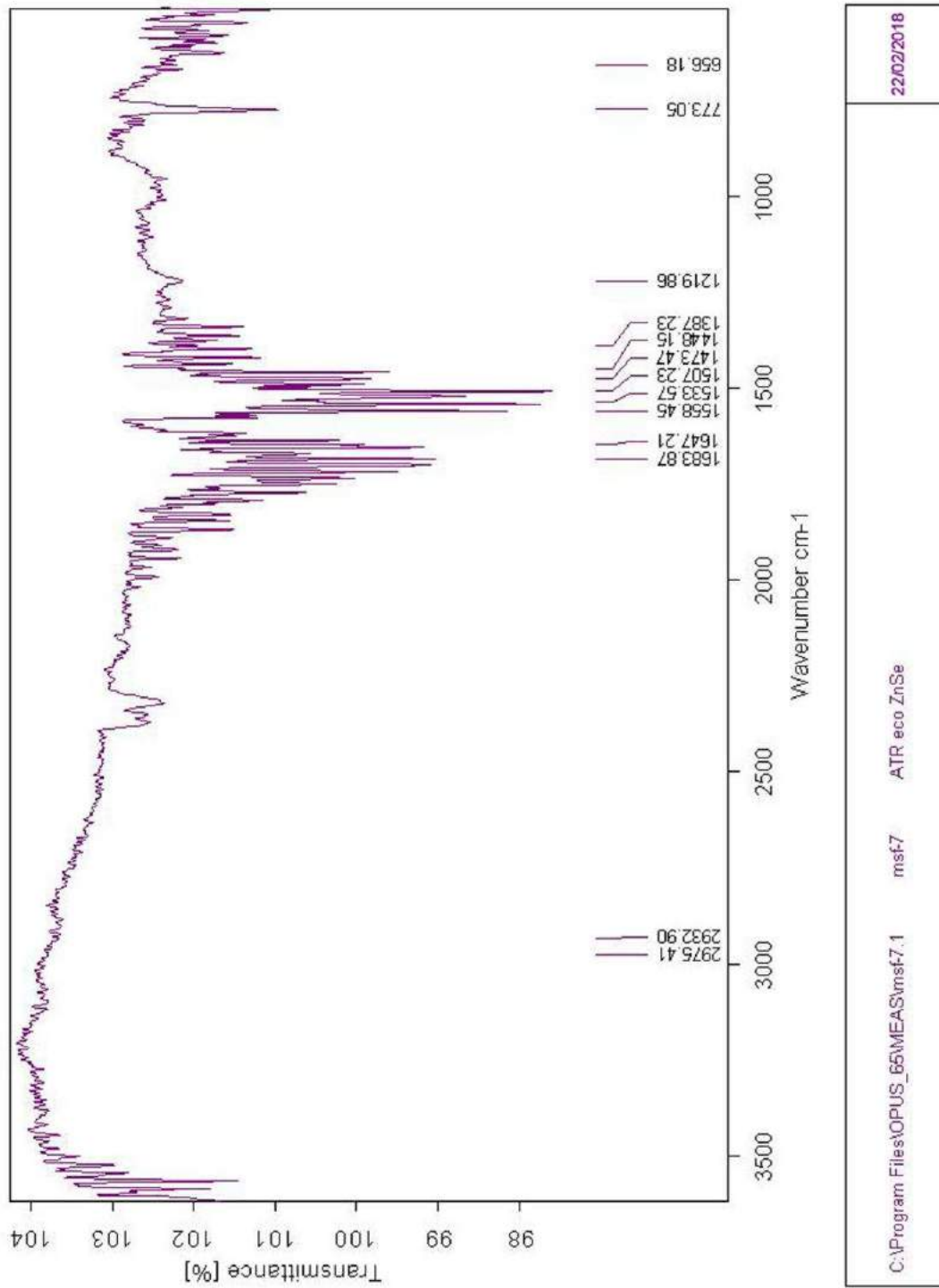


C:\Program Files\OPUS_65\MEAS\msf5.1 msf-5 ATR eco ZnSe 21/02/2018

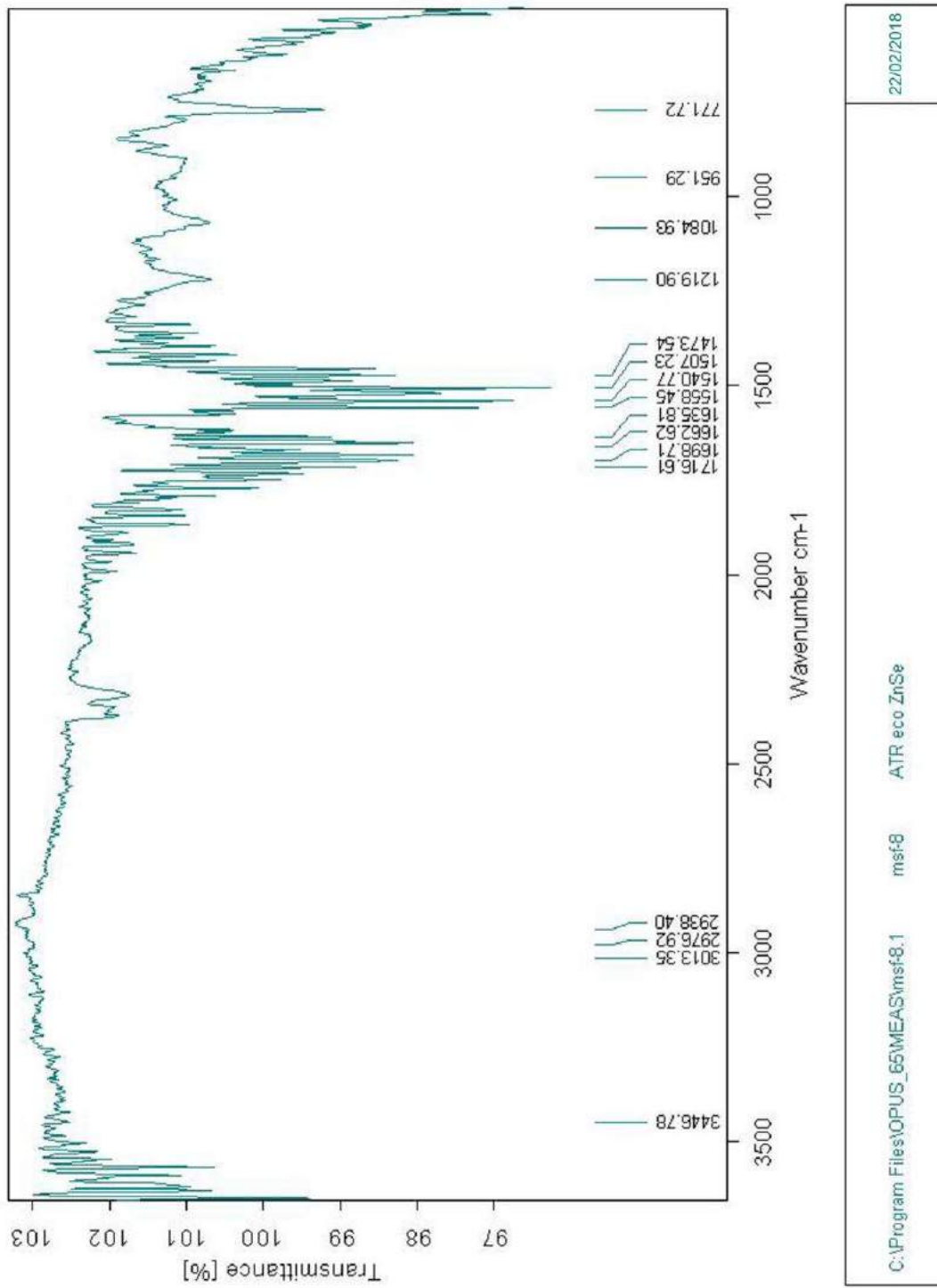
Spectrum 17: IR Spectrometer of synthesized compound 7k



Spectrum 18: IR Spectrometer of synthesized compound 7I

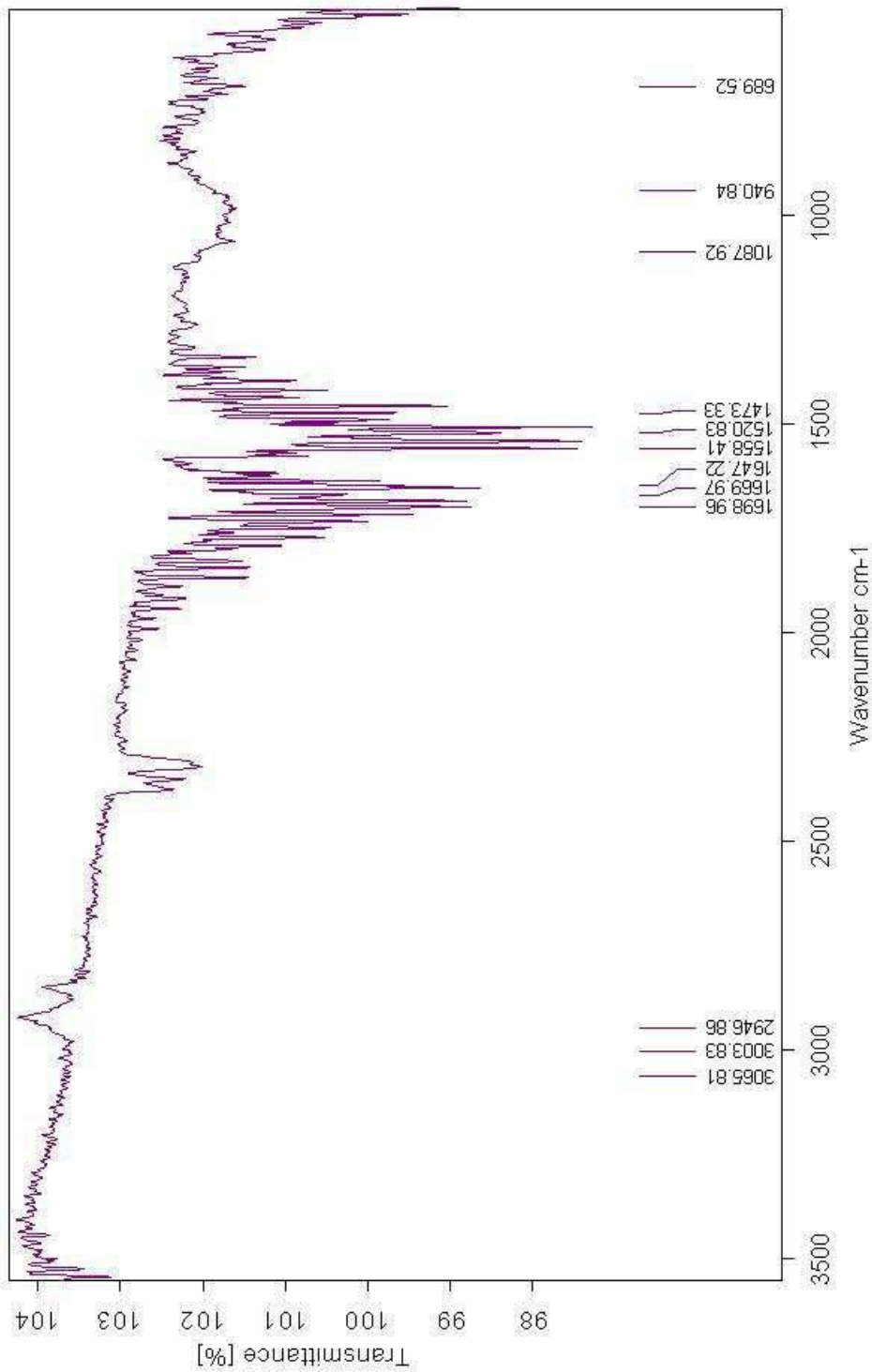


Spectrum 19: IR Spectrometer of synthesized compound 7m



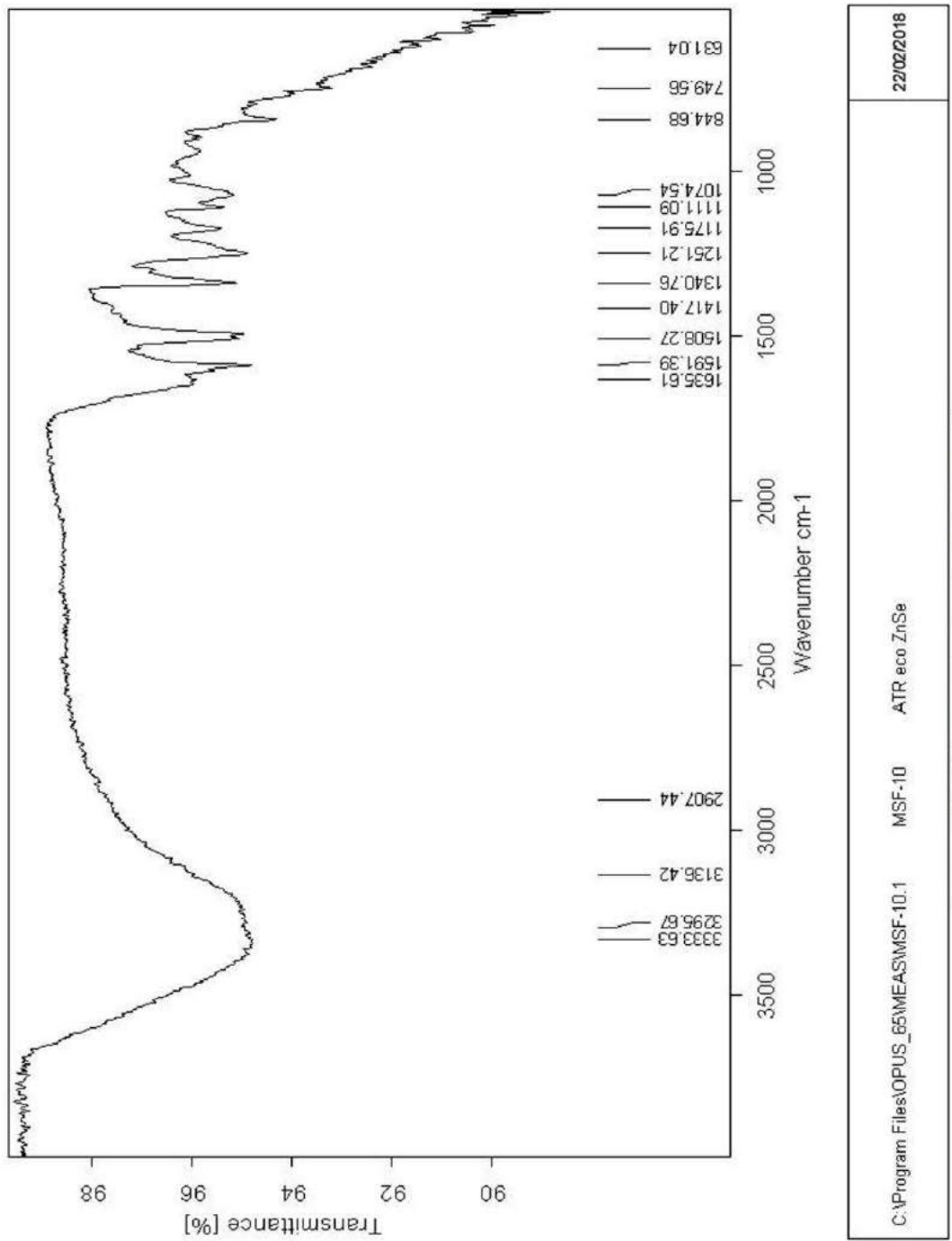
C:\Program Files\OPUS_65\MEAS\msf8.1 msf8 ATR eco ZnSe 22/02/2018

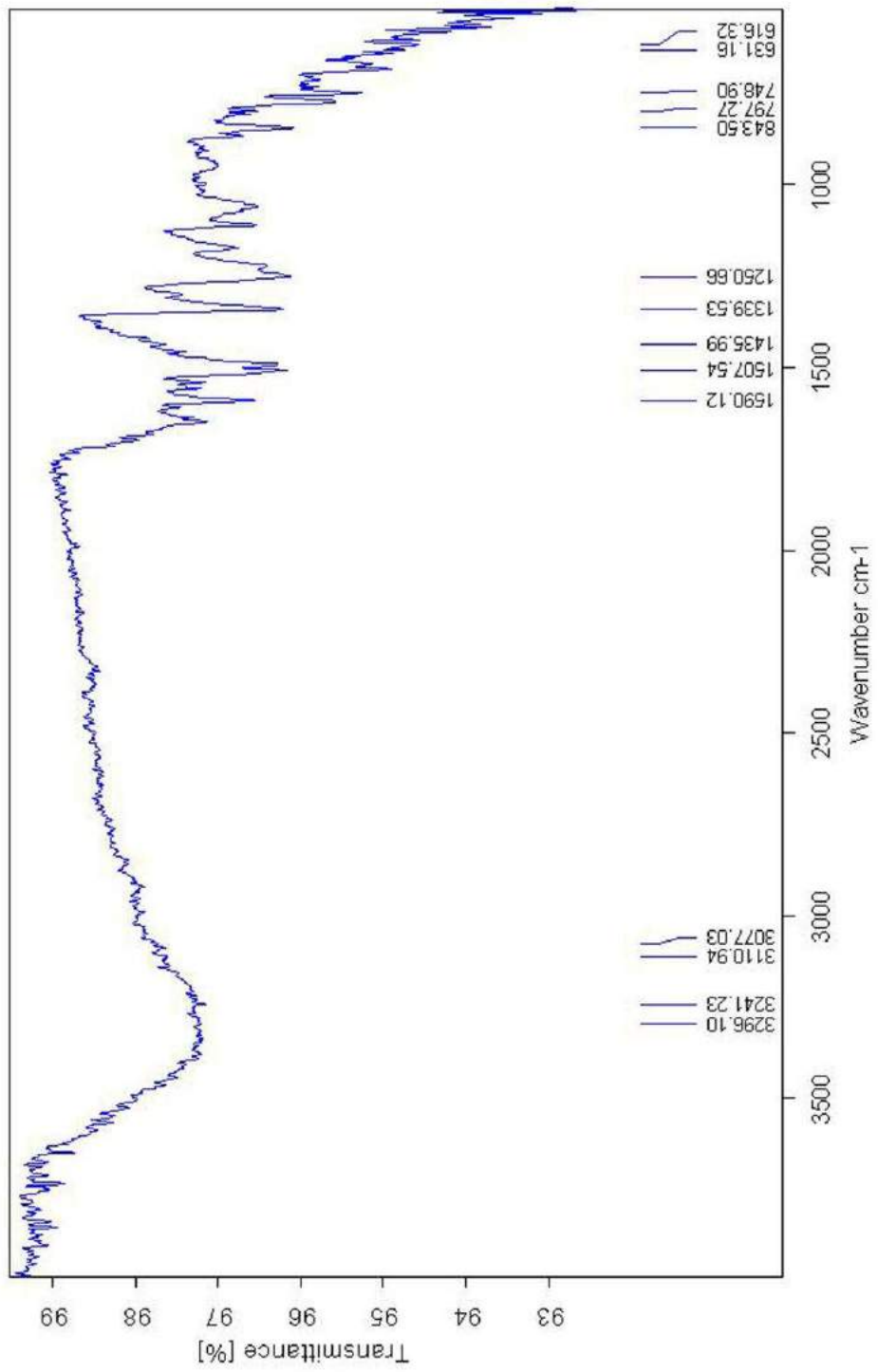
Spectrum 20: IR Spectrometer of synthesized compound 7n



C:\Program Files\OPUS_65\MEAS\MSF-9.0 MSF-9 solid 22/02/2018

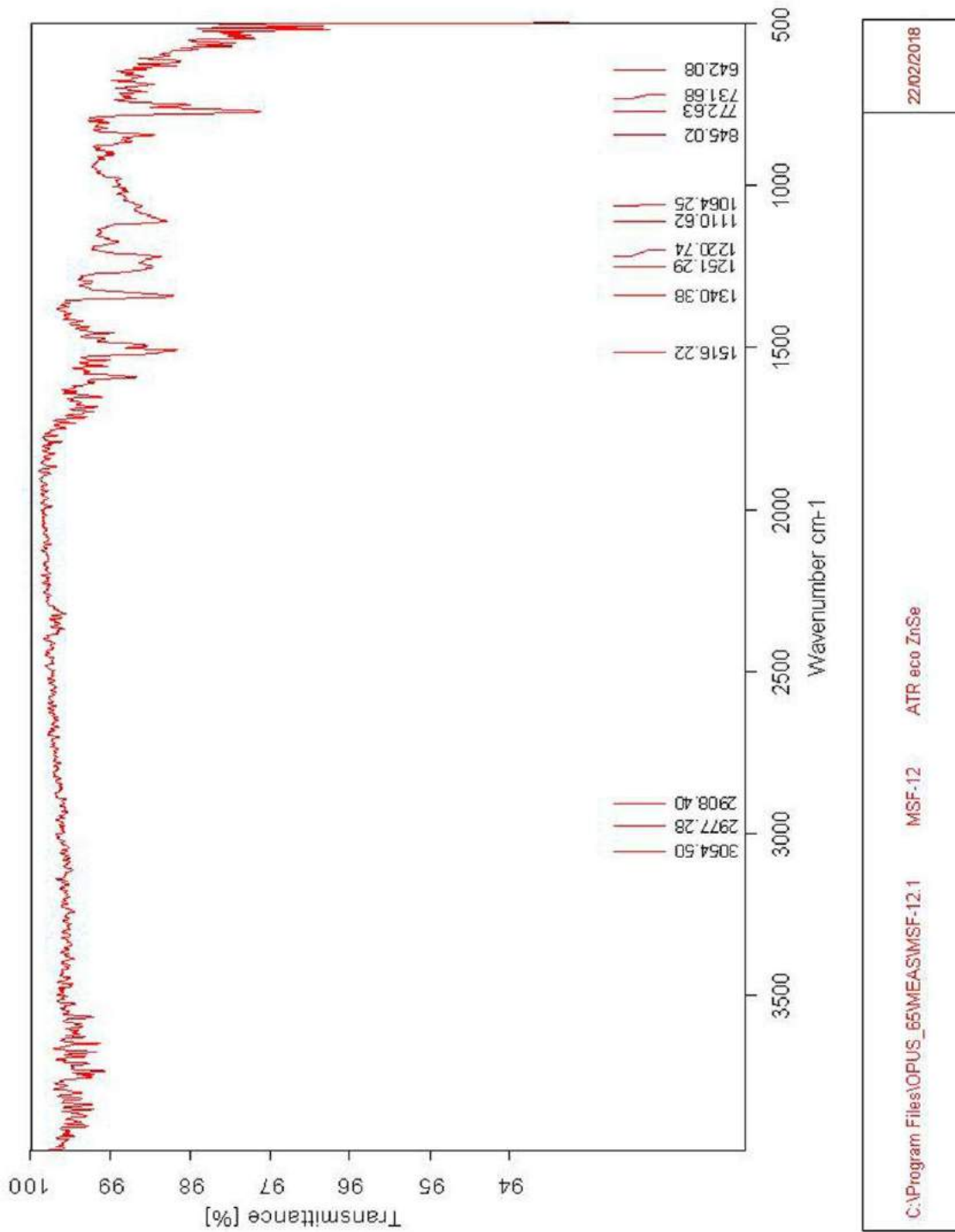
Spectrum 21: IR Spectrometer of synthesized compound 7o

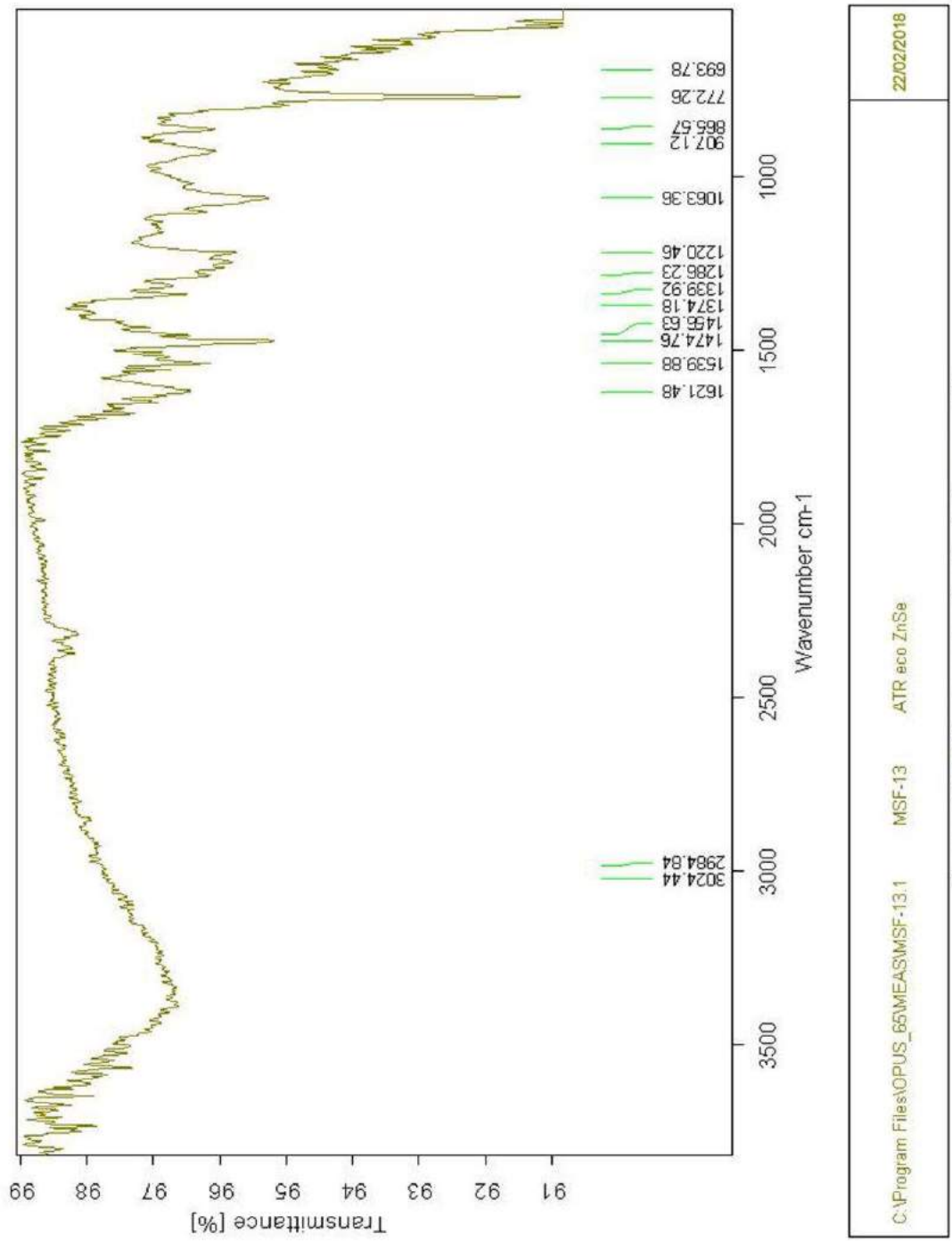


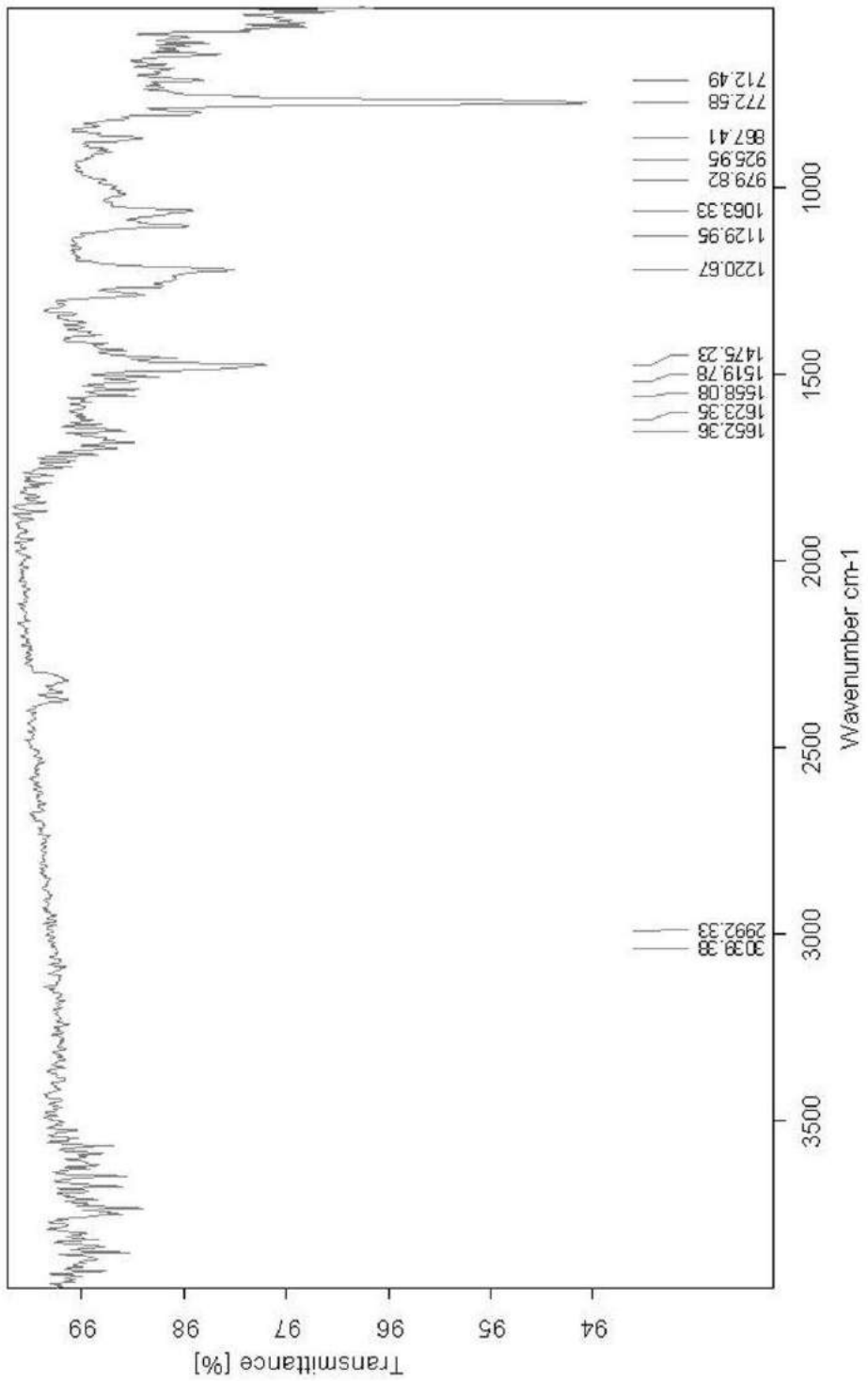


C:\Program Files\OPUS_65\MEAS\MSF-11.1 MSF-11 ATR eco ZnSe 22/02/2018

Spectrum 23: IR Spectrometer of synthesized compound 7q

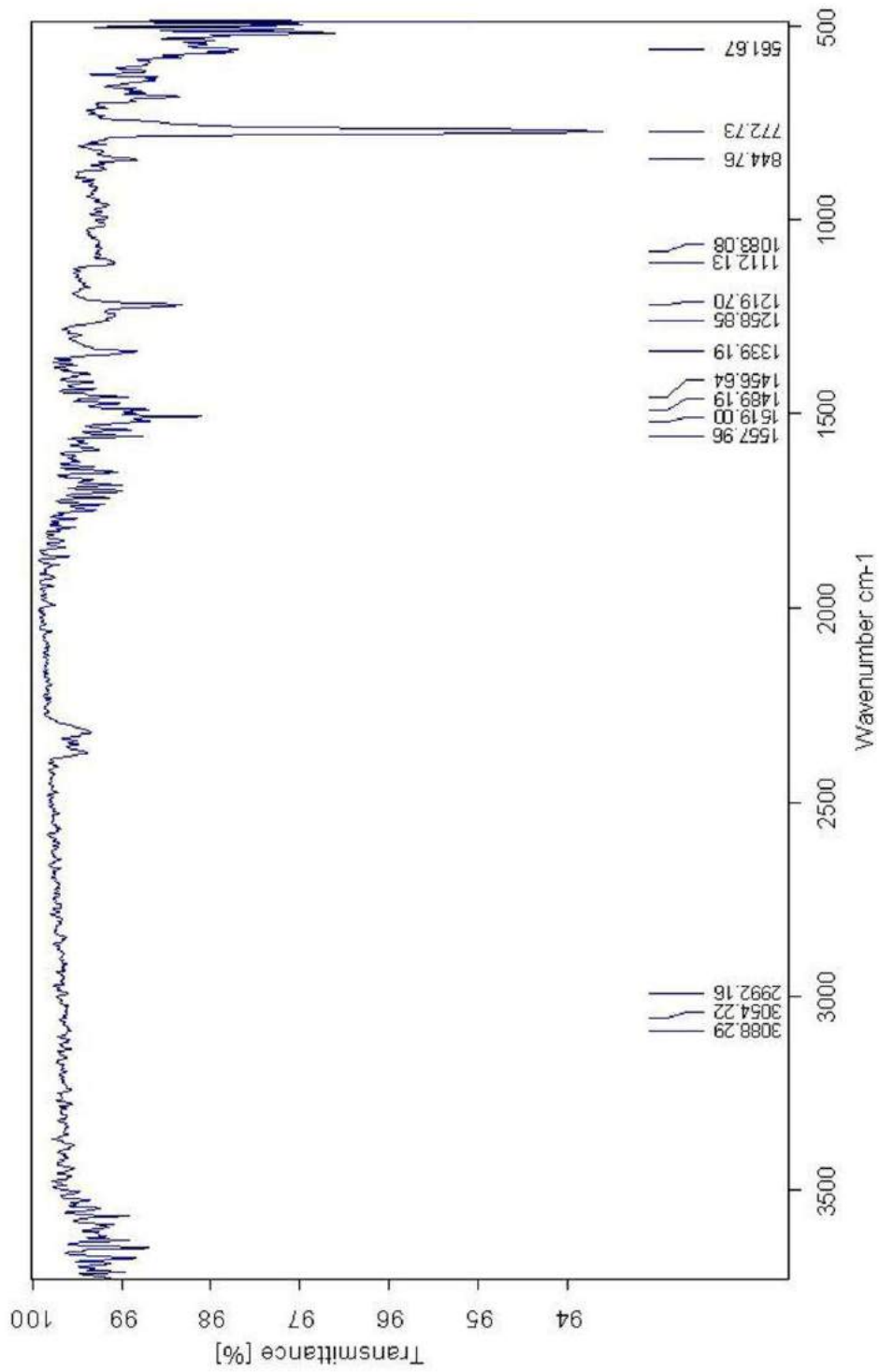






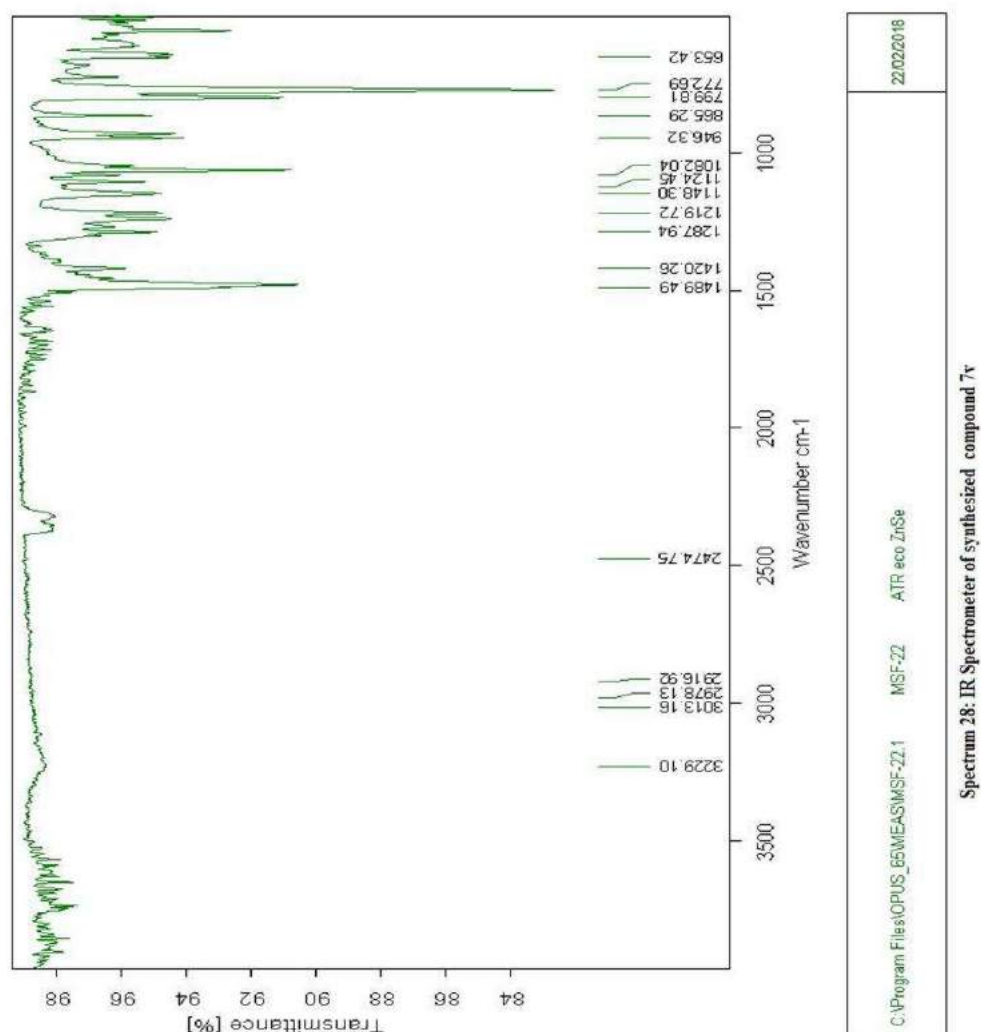
C:\Program Files\OPUS_65\MEAS\MSF-14.3 MSF-14 ATR eco ZnSe 22/02/2018

Spectrum 26: IR Spectrometer of synthesized compound 7t



C:\Program Files\OPUS_65\MEAS\MSF-15.1 MSF-15 ATR eco ZnSe 22/02/2018

Spectrum 27: IR Spectrometer of synthesized compound 7u



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