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Nematogenic Mesophase Induced from Two Nonmesomorphs and Determination of LTT for Common Nonmesomorphic Component by Extrapolation

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ABSTRACT

Three binary systems ($A+B_1$, $A+B_2$, $A+B_3$) consisted of both admixed components as nonmesomorphs induces mesomorphic property as nematogenic mesophase within definite range of concentration of component - A. The Isotropic- Nematic (I-N) transition curves of each binary systems are extra polated to 100 mole percent of nonmesomorphic component –A to determine its reliable latent transition temperature (LTT) and to derive the group efficiency order. The common component A is a Schiff's base, P-tolal. P'- Phenetidine (109 °C), uncommon component B_1 and B_2 are also Schiff's bases p-Chloro benzal P'- chloroaniline (M.P 111.0 °C) and p-Anisal p'-Toluidine (M.P 92.0 °C) respectively, whereas, component B_3 is a chalcone α- 4 methoxy phenyl β 4'-pentyloxy benzoyl ethylene (M.P 91.0 °C). The reliable predicted LTT of common component –A are 99.5 °C, 99.0 °C and 101.0 °C from binary systems $A+B_1$,$A+B_2$ and, $A+B_3$ respectively. The group efficiency order derived is $B_2>B_1>B_3$ from range of mesomorphism.The melting point of common and uncommon nonmesomorphic components are confirmed with previously reported values. Suitable magnitudes of anisotropic forces of intermolecular attractions as a consequence of resulted molecular rigidity and flexibility through respective polarity and polarizabilities of nonmesogenic components of the mesogenic mixitures which play an important role in inducing mesomorphism.

***Keywords*:** Mixed mesomorphism, Nematic, Binary System, Mixed melt, Eutectic point

1. INTRODUCTION

Normaly many of the substances possess three physical states or two state (solid NH_4Cl) of matter as solid, liquid, gas or vapor. But some of the substances as exhibit four different physical states of matter i.e. an intermediate state between crystalline solid and isotropic liquid, which flows like isotropic liquid but have an optical properties like solid crystals. Such substances are termed as liquid crystal (LC) or mesomorphs [1]. Rest of the substances with two or three physical states are called nonmesomorphs or nonliquidcrystals (NLC) or nonmesogenic or nonmesomorphic. Such nonmesomorphic substances have the potential ability to exhibit mesomorphism, because theoretically every substance should have potential to exhibit four different physical states of matter. But the range of temperature of invisible or missing state may be so short that one or two physical states become undetectable or missed to locate at some low temperature or room temperature therefore such nonmesomorphs can be studied to determine their latent transition temperature (LTT) by mixing with one or none mesomorphs in binary system and then by extrapolating the mesomorphic – isotropic or vise varsa transition curve smoothly to 100 or zero mole percent of a nonmesomorph [2-7]. Number of binary systems with one or none or both mesomorphic components have been studied by early workers [8-23]. The constituent component of a binary system (i) should not interact with each other (ii) should form homogeneous mixture (iii) similar shape and size (iv) five to ten degree difference in melting temperatures and (v) should follow thermodynamically laws of mixtures. Such study is useful for the manufacture of devices to be operated at desired temperature at higher or lower temperatures [15-19].

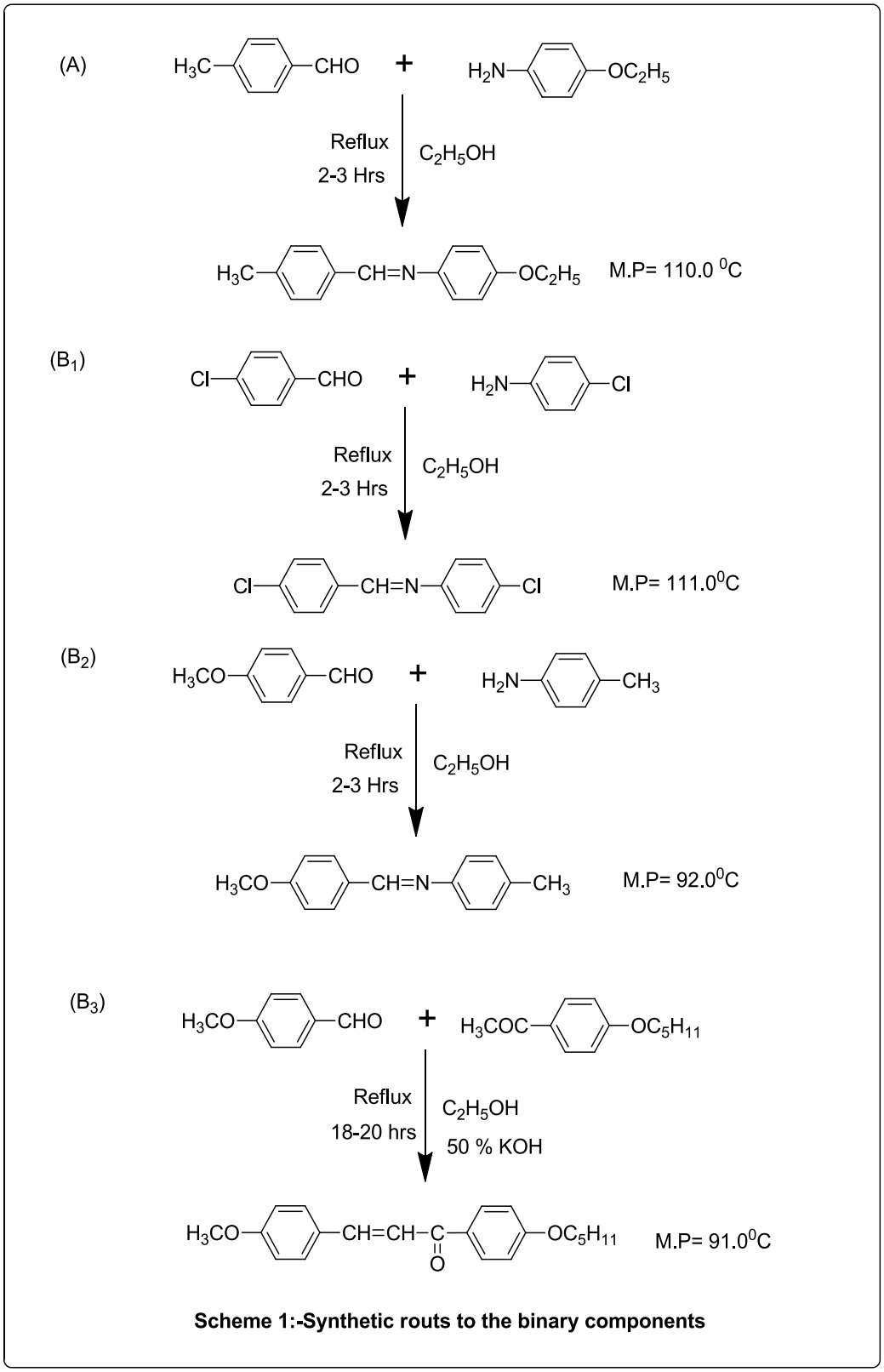
2. EXPERIMENTAL

Synthesis

Schiff's base A, B_1, and B_2, were synthesized by usual established by refluxing condensing [24] equimolar proportion of corresponding Aldehyde and amine in alcohol for about two to three hours. Chalconyl component B_3 was synthesized by usual established [25] method by reacting corresponding Aldehyde and Acetophenone products were isolated, dried, purified and crystalized in alcohol till their reported melting temperature obtained. M.P of A, B_1, B_2, B_3 were confirmed to their respective reported values as mentioned above.

3. RESULTS AND DISCUSSION

The transition temperatures of pure components A, B_1, B_2 and B_3 and binary mixtures are (Table 1) as determined by an optical polarizing microscopy (POM) equipped with a heating stage were plotted versus the mole percent of nonmesomorphic component A or B and the phase diagram obtained for the binary systems A+B_1, A+B_2 and A+B_3 are shown in Figure 1, Figure 2 and Figure 3 respectively. Table 2, 3 & 4, consists of transition temperatures and mole percent of binary mixtures. Latent transition temperatures determined and predicted for nonmesogenic component -A are recorded in Table 1.



Scheme 1:-Synthetic routs to the binary components

The maximum proportion of composition range over which mesophase persistence of nonmesogenic components A or mesophase induced as nematogenic mesomorphism for the binary systems A+B_1, A+B_2 and A+B_3 are 51.12 to 90.39, 28.74 to 89.44 and 57.54 to 92.45 respectively.

Therefore the disruption of mesomorphic alignments caused by second uncommon nonmesogenic components B_2 (28.74 to 89.44) is minimum and by the component B_3 is maximum (53.54 to 92.45). Whereas for nonmesogenic second uncommon component B_1 (51.12 to 90.39) is less than B_3 and more than B_2. Thus, the order of disruption of nematogenic mesophase persistence on the basis of disruption of mesogenic alignments in mixed melt or efficiency to induce nematogenic character can be determined as $B_2>B_1>B_3$ with common nonmesomorphic component –A of the binary systems under present study. The LTT predicted and determined for a nonmesomorphic component (A) p-Tolual – p'phenetidine through binary systems containing nomesomorphic component B_1, B_2 or B_3 are 95.0 °C, 90.0 °C and 101.0 °C respectively. The LTT determined and predicted for a common component (A) are compared with other binary systems reported earlier (4, 5, 6, 7) are mentioned below in Table -1.

Table 1. LTT Comparison with different B component

Sr. No	Binary system A+B (second component) (B)	(Present study) LTT predicted in °C for common component (A)	Ref.7	Previous work			
				Ref.-3	Ref.-2	Ref.-6	Ref.-6
1	B_1(Cl-C_6H_4CH=N-C_6H_4-Cl)	95.0	-	-	-	-	-
2	B_2(OCH_3-C_6H_4CH=N-C_6H_4-CH_3)	90.0	-	-	-	-	-
3	B_3(OCH_3-C_6H_4CH=CH-CO-C_6H_4-OC_5H_{11})	101.0	-	-	-	-	-
4	C_3H_7O-C_6H_4-COO-C_6H_4-OCH_3	-	-	87.0	-	-	-
5	Trans CH_3O-C_6H_4CH=CH-COO-C_6H_4-OCH_3	-	-	-	90.0	-	-
6	$C_{12}H_{25}O$-C_6H_4-COO-$C_{10}H_6$-N=N-C_6H_5	-	-	-	-	84.0	-
7	$C_{10}H_{21}O$-C_6H_4-COO-$C_{10}H_6$-N=N-C_6H_4-Cl	-	-	-	-	-	102.0
8	CH_3O-C6H_4-COO-C_6H_4-OCH_3	-	81.6	-	-	-	-

The suitable magnitude of anisotropic force of intermolecular attraction as a consequence of favorable magnitudes of molecular rigidity and flexibility which can facilitate exhibition or commencement of mesophase, particularly in present investigation. nematogenic mesophase formation in a homogeneous mixed melt of the binary systems. The disruption caused by components (B) in any binary systems or mixed melt is due to the low magnitudes of dipole –dipole interactions, resulted from the degree of similarity of constituent

components (A+B) of a binary system in shape ,size ,polarity and polarizability of terminal, lateral or central groups or composition of mixture affecting magnitudes of intermolecular cohesive forces. The compositions and range of mesomorphism induced from binary systems $A+B_1$, $A+B_2$ and $A+B_3$ (Both component A and B nonmesomorphs) are mentioned above which disaligned the molecules involved in concerned compositions prior to 100 mole percent of A, facilitated to arrange the molecules in statistically parallel orientational order by an angle less than ninety degree with floating surface for shorter range of temperatures below isotropic temperature. Thus, nematic mesophse induced from binary systems consisting from two nonmesomorphs A and B. However, the inter molecular forces of all the composition of all the binary systems of present investigation fails to organize molecules of constituent components of binary systems together in lamellar paking to facilitate the formation of layered or sliding layered smectogenic molecular arrangement under thermometric cooling treatment of sample on floating surface. Thus, smectic mesophase below monotropic nematic phase does not appear prior to solidification.

Binary System-$A+B_1$

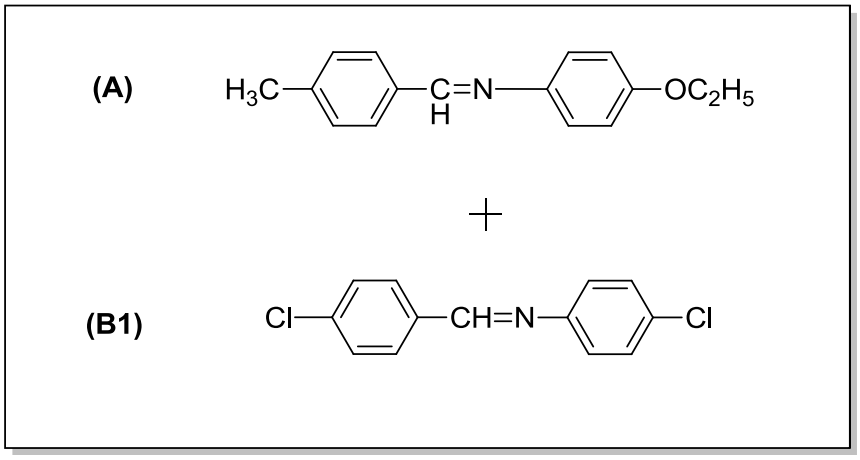


Table 2. Transition Temperatures of Binary System $A+B_1$

Sr. No.	Mole % of Component (A)	Transition Temperature in (ºC)		
		Smectic	Nematic	Isotropic
1	0.0	-	-	111.0
2	10.41	-	-	103.0
3	20.72	-	-	100.0
4	30.95	-	-	100.0
5	41.08	-	-	108.0

6	51.12	-	(98.0)	109.0
7	61.07	-	(99.0)	110.0
8	70.93	-	(98.0)	110.0
9	80.71	-	(100.0)	110.0
10	90.39	-	(99)	111.0
11	100	-	-	109.0

( ) Indicates monotropy

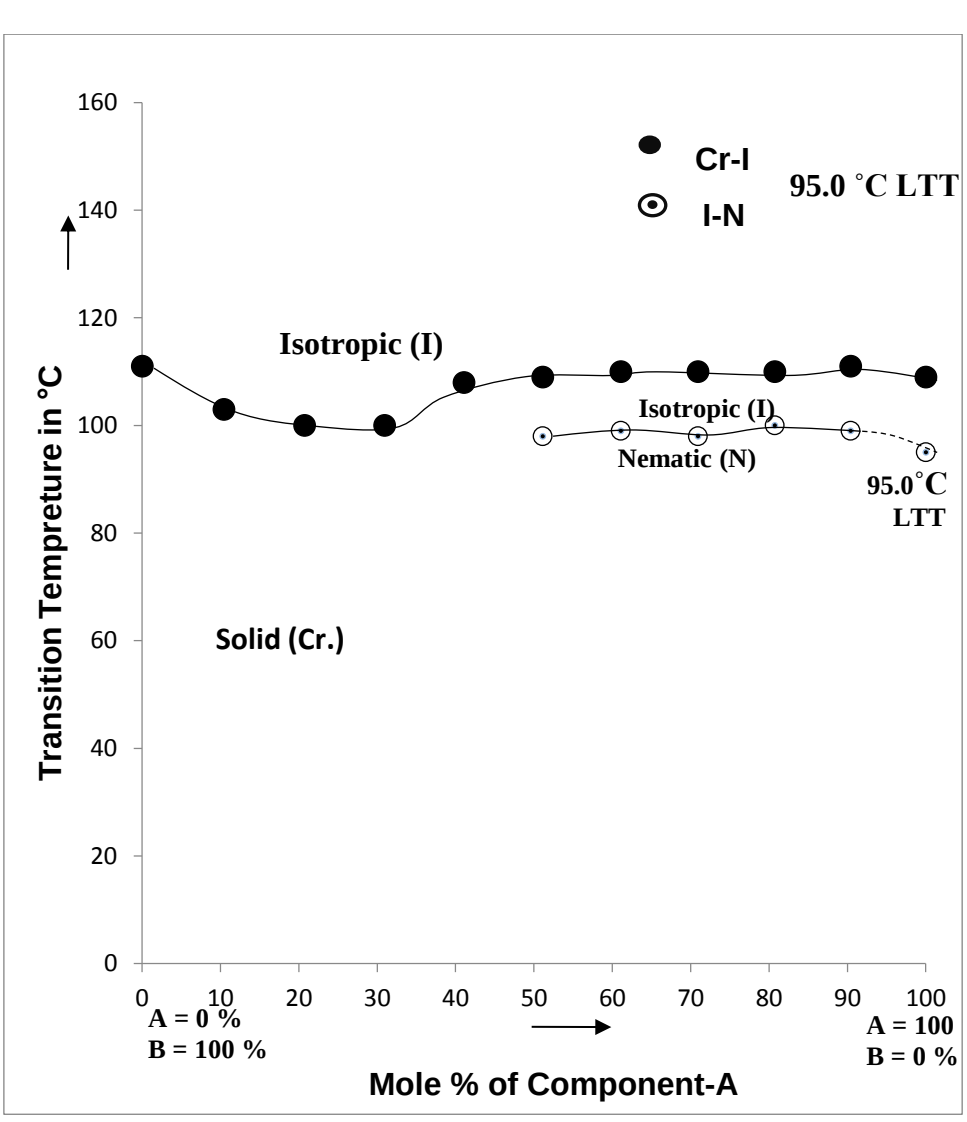


Figure 1. Phase behavior of binary system A+B_1

Binary System-A+B_2

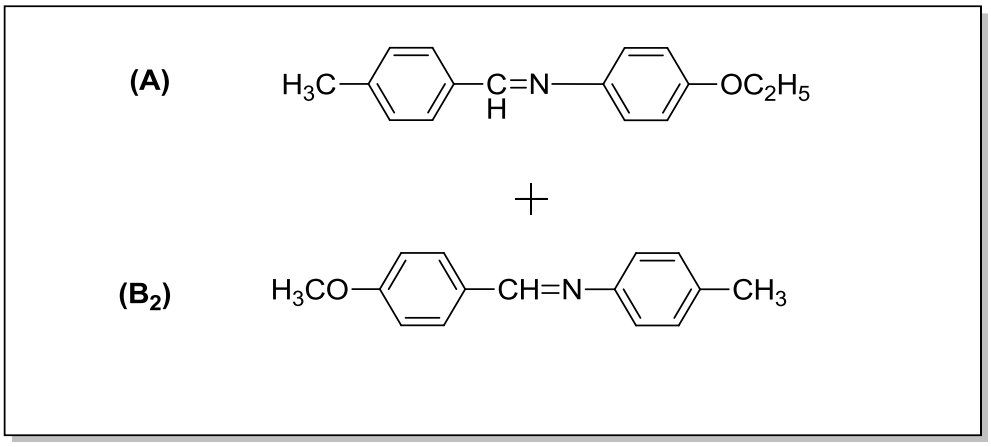


Table 3. Transition Temperatures of Binary System A+B_2

Sr. No.	Mole % of Component (A)	Transition Temperature in (ºC)		
		Smectic	Nematic	Isotropic
1	0.0	-	-	92.0
2	9.4	-	-	85.0
3	19.05	-	-	83.0
4	28.74	-	(76.0)	82.0
5	38.56	-	(88.0)	106.0
6	48.49	-	(89.0)	107.0
7	58.54	-	(91.0)	108.0
8	68.71	-	(92.0)	108.0
9	79.01	-	(93.0)	112.0
10	89.44	-	(92.0)	111.0
11	100	-	-	109.0

( ) Indicates monotropy

$A+B_2$

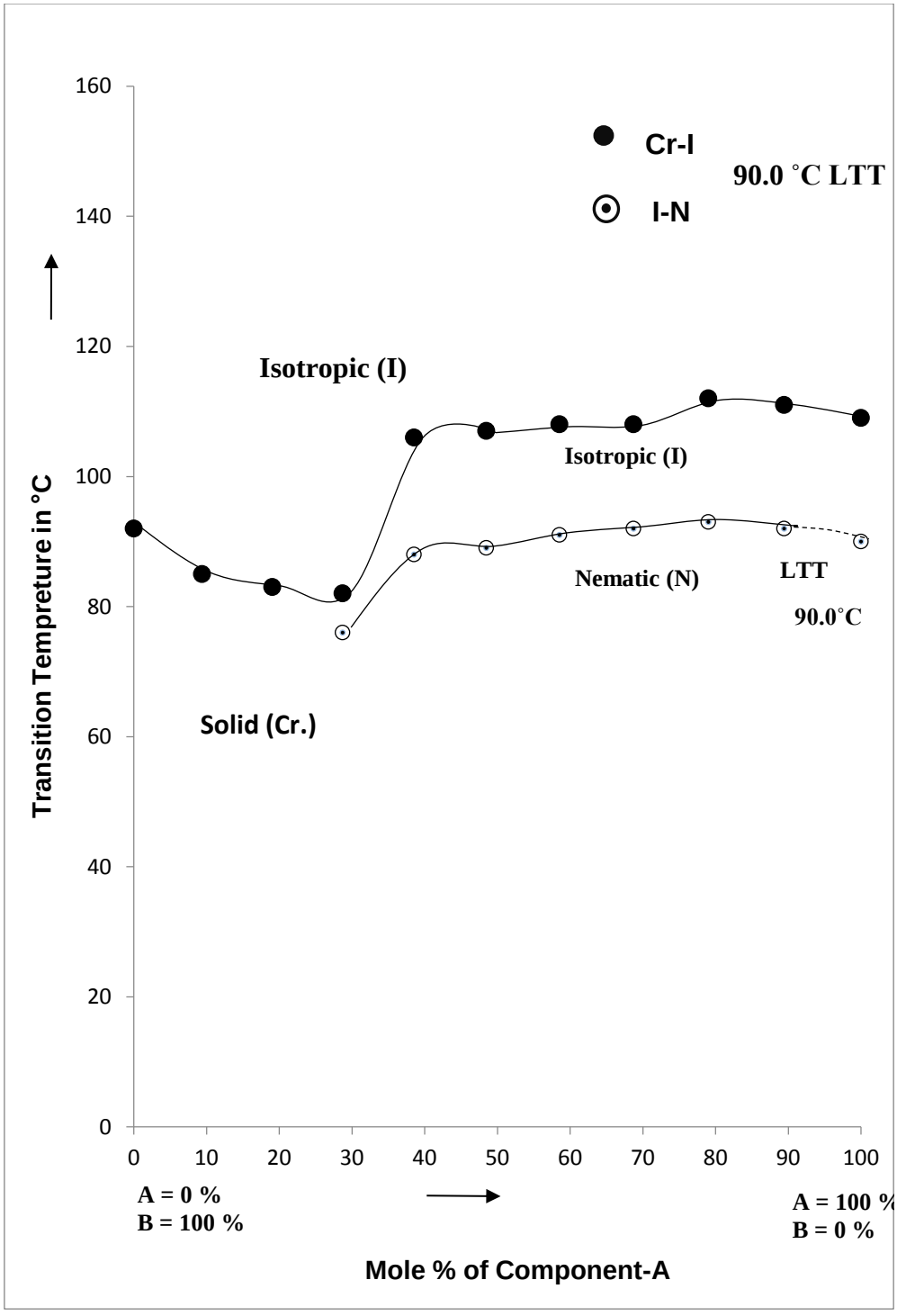


Figure 2. Phase behavior of binary system $A+B_2$

Binary System-A+B_3

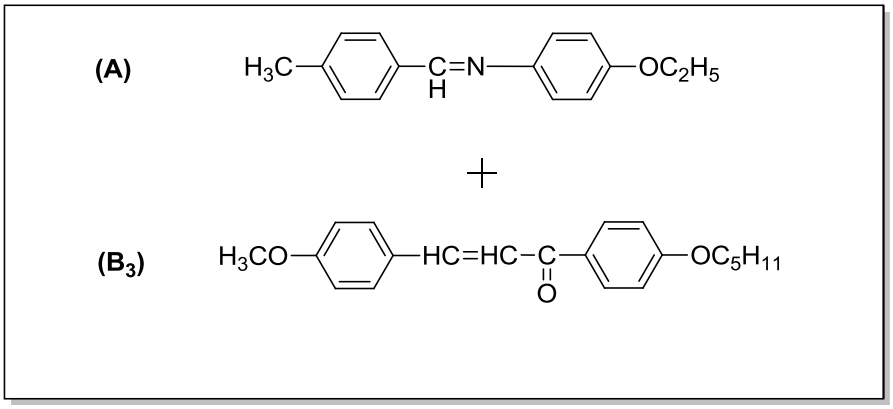


Table 4. Transition Temperatures of Binary System A+B_3

Sr. No.	Mole % of Component (A)	Transition Temperature in (ºC)		
		Smectic	Nematic	Isotropic
1	0.0	-	-	91.0
2	13.09	-	-	108.0
3	25.31	-	-	109.0
4	36.74	-	-	109.0
5	47.47	-	-	113.0
6	57.54	-	(99.0)	112.0
7	67.03	-	(101.0)	110.0
8	75.97	-	(97.0)	112.0
9	84.42	-	(98.0)	111.0
10	92.45	-	(100.0)	110.0
11	100	-	-	109.0

( ) Indicates monotropy

$A+B_3$

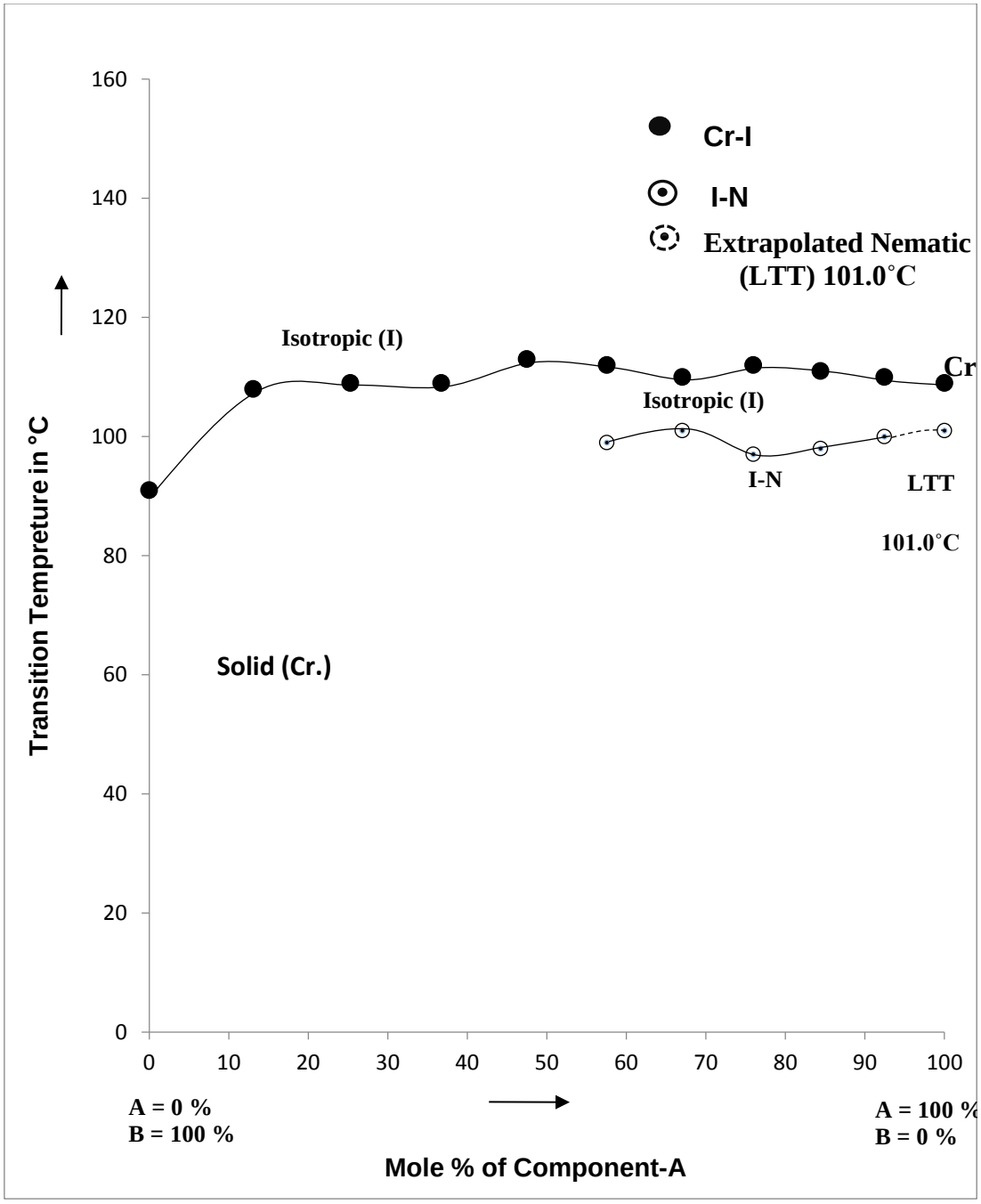


Figure 3. Phase behavior of binary system $A+B_3$

The reliability or accuracy of predicting LTT is depended upon homogeneity and the temperature difference between constituent components of the binary mixtures as a result of similarity shape and size. Also it depends upon the negligible degree of interaction between constituent components following of laws of mixtures and the dipole- dipole interaction or

their permanent dipole moments across the longer molecular axis of constituents components of mixtures which reflects in the suitable magnitudes of anisotropic force of intermolecular attraction to cause mesomorphism as a consequence of molecular polarities, polarizabilities, rigidity and flexibility which occurred from terminal , central and lateral group or groups in a mixed melt under exposed thermometric vibration in floating condition. The observed minor difference in predicting LTT (Table -1) of a component –A p- tolal –p' phenetidine is attributed to the differing magnitudes of above mentioned factors or desimilarity in molecular structure of uncommon component of a binary system other than –A between constituent components of a binary mixture.

4. CONCLUSIONS

(i) The extrapolation could be quite dependable when the nomesomorphic constituent components are structurally similar and possess sufficiently polar terminal end groups or lateral or central groups. Of course for greater dependability of the extrapolation method the Cr- I curve should preferably be in equilibrium with anisotropic liquids and the substituted groups of nonmesomorphic components should be sufficiently polar.

(ii) The evidence obtained by the present investigation place the extrapolation hypothesis on sound footing. Hence present study raises credibility to the conclusions drawn earlier.

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