

# Synthesis of Photoconducting Polyimide of Indole-diphenyl amine Moiety.

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## Abstract:

*N*-ethyl-3-nitro indole was prepared by treating 3-nitro indole with ethyliodide in presence of sodium hydride. *N*-ethyl-3-amino indole was synthesized by the reduction of *N*-ethyl-3-nitro indole with sodium dithionite and 0.5(N) sodium hydroxide solution in the solvent medium of ethanol at 50<sup>o</sup>c. *N*-ethyl-3-(4,4'-dinitro diphenyl amino) indole was synthesized by the reaction of *N*-ethyl-3-amino indole with 4-fluoro nitro benzene in presence of cesium fluoride in the solvent medium of DMSO under reflux at 120<sup>o</sup>C for 20h. *N*-ethyl-3-(4,4'-diamino diphenyl amino) indole was synthesized by the reduction of *N*-ethyl-3-(4,4'-dinitrodiphenyl amino) indole with palladium-carbon in presence of hydrazine hydrate under reflux at 130<sup>o</sup>c for 12h. Polyimide was synthesized by the reaction of *N*-ethyl-3-(4,4'-diamino diphenyl amino) indole with 6FDA in (1:1) molar ratio under heating firstly at 40<sup>o</sup>c for 24h, resulting polyamic acid which was subsequently treated with acetic anhydride and pyridine at 100<sup>o</sup>c for 24h in the solvent medium of DMF.

**Keywords:** *N*-ethyl-3-nitro indole, *N*-ethyl-3-amino indole, *N*-ethyl-3-(4,4'-dinitro diphenyl amino) indole, *N*-ethyl-3-(4,4'-diamino diphenyl amino) indole, 6FDA, polyimide.

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## I. Introduction:

Carbazole derivatives are well-known to exhibit good electro and photo active properties due to their high hole transporting mobility, strong absorption in the ultra violet spectral region and blue-light emission. Since the discovery of photoconductivity in poly(*N*-vinyl carbazole), carbazole-containing derivatives become the subject of numerous investigations for applications in electro photo graphy. The second wave of interest in carbazole-based CTMS is connected mostly with the discovery of organic light-emitting diodes and photorefractive materials. Apart from the electrophotographic photoreceptors, light-emitting diodes, and photo refractive materials, carbazole-containing transporting materials are studied as the components of photo-voltaic devices and field-effect transistors. Commercial availability and relative cheapness of the starting materials, simple synthesis, number of sites available for easy functionalization, good charge drift mobility and solubility in common organic solvents make these precursors attractive building blocks for the construction of more complex materials for optoelectronic applications.

Photorefractive polymers have attracted considerable attention owing to potential applications including high-density optical data storage, optical image processing, phase conjugation, lasing, dynamic holography, optical computing and pattern recognition. The necessary characteristics for a material to be regarded as potentially photorefractive are photoconductivity. Polymer can be made either incorporating these properties directly into polymer (fully functionalized polymer) or doping guest molecules into the polymer (guest-host polymer composite) to produce these properties. Most of photorefractive polymers reported to date are based on guest-host polymer composite, which normally consist of four components (photoconducting polymer host, NLO chromophore, plasticizer and photosensitizer). We have synthesized and reported various photoconducting polymers based on heteroaromatic donor moiety like carbazole and indole.

Indole is another heteroaromatic molecule which is easily available from coal-tar and has donor moiety like carbazole. Indole, the heteroaromatic structure like carbazole was designed to work as photoconducting moiety as well as electron donor. Indole was adopted over carbazole for this purpose, because indole provides better poling efficiency owing to the more compact size compared with carbazole. Indole has good thermal and mechanical properties. It easily formed C.T. complex with TNF and crystal violet and forming hole that will migrate the polymer chain. Diphenylamine like triphenylamine has also electron donating ability.

In this article, we have synthesized polyimide of indole diphenylamine moiety. It is a guest-host system polymer where the host polymer matrix can be doped with guest molecule like TNF. A good photorefractive system can be developed by conjugation the polymer with a second order NLO chromophore, plasticizer and photosensitizer.

## II. Experimental:

### 2.1. Synthesis of N-ethyl-3-nitro indole:

To a three necked round-bottom flask equipped with nitrogen purge and reflux condenser was added 3.24g(0.02mol) of 3-nitro indole along with 75 ml of anhydrous DMF. To the stirred solution was added 0.72g (0.03 mol) of sodium hydride. Immediately a precipitate formed with evolution of hydrogen gas. This was stirred for further 15 minutes to dissolve the indole anion Then 4.68g(0.03 mol) of iodoethane was added in one portion. After 10h, 200ml of water was added to give a precipitate. The product was recrystallized from chloroform.

### 2.2. Synthesis of N-ethyl-3-amino indole:

A solution of 3.0 g of sodium dithionite in 15 ml 0.5(N) sodium hydroxide solution was added to a solution of 0.50g of N-ethyl-3-nitro indole in 35 ml of ethanol and 10ml (N) sodium hydroxide solution at 50<sup>0</sup>c . The mixture was then filtered hot, and the filtrate was evaporated to dryness. The residue was dissolved in 5% hydrochloric acid solution, filtered and made basic with cold 30% sodium hydroxide. The basic solution was extracted with ether and then evaporated to dryness.

### 2.3. Synthesis of N-ethyl-3-(4,4'-dinitro diphenyl amino ) indole:

In a round-bottom flask 250ml with a magnetic bar, 4.8g (0.03mol) of N-ethyl-3-amino indole, 8.46g(0.06mol) of 4-fluoro nitrobenzene and 9.20g (0.06mol) of cesium fluoride in 80ml of DMSO were refluxed to 120<sup>0</sup>c for 20h. The final solution was stream into 200ml solution of methanol/water (1:1) to get precipitate . After filtration which was washed with methanol and water several times and recrystallized from DMF/methanol to give crystals.

### 2.4.Synthesis of N-ethyl-3-(4,4'-diamino diphenyl amino) indole:

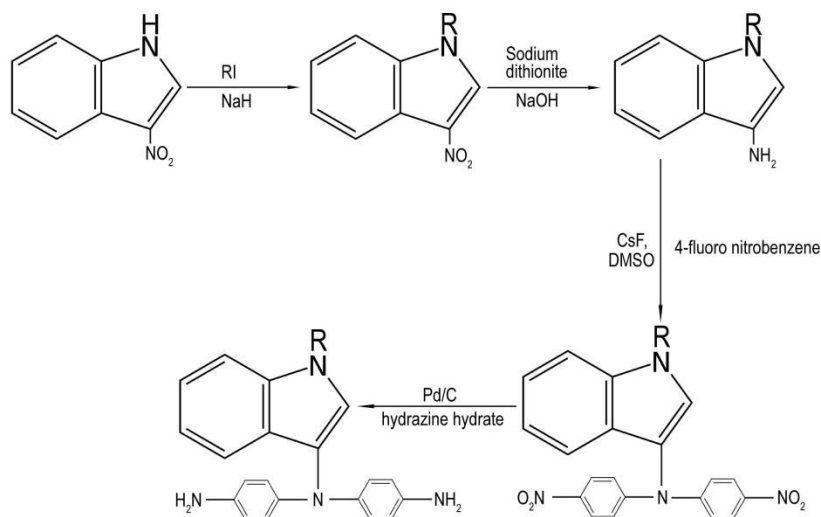
In a 250ml stirred round bottom flask, 10.05g(0.025mol) dinitro intermediate, 0.20g 10wt% Pd/C, 10ml of hydrazine hydrate in 120ml of ethanol are refluxed at 130<sup>0</sup>c for 15h. Then the Pd/C powder was separated by filtration of the hot crude. The filtrate was cooled and poured into water. The precipitate was filtered and dried.

### 2.5 synthesis of polyimide:

Monomer, N-ethyl-3-(4,4'-diamino diphenylamino) indole (1mmol) and 6FDA (1mmol) were dissolved in DMF (20ml). The solution was stirred at 40<sup>0</sup>c under nitrogen for 24h yielding a viscous polyamic acid solution. To this solution acetic anhydride (12ml) and pyridine (6ml) were added. The stirring was continued at 100<sup>0</sup>c for 24h. Then the reaction mixture was poured into methanol, the polymer was filtered and purified by washing with methanol.

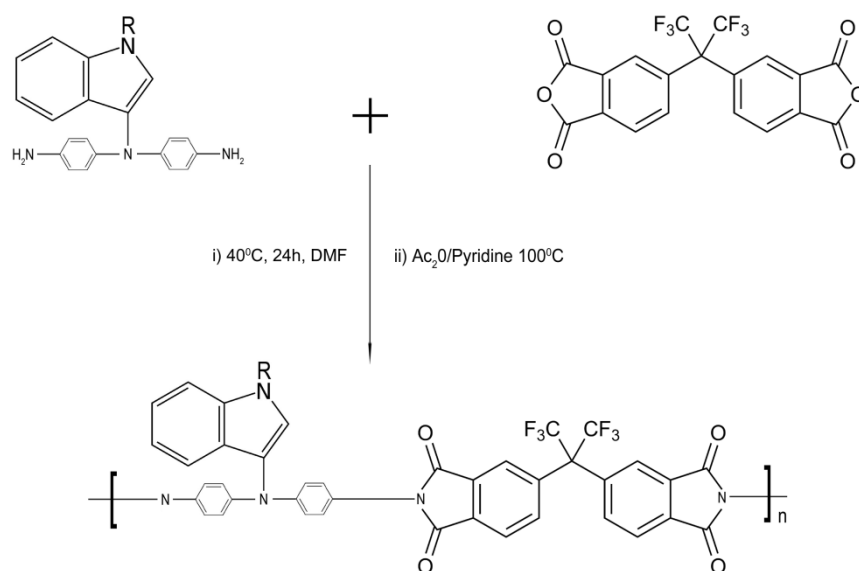
## III. Results and Discussion:

IR, UV and NMR spectra revealed the successful preparation of the polymer. N-ethyl-3-nitro indole was prepared by the reaction of 3-nitro indole with ethyl iodide in presence of sodium hydride in the solvent medium of DMF. After subsequent reaction, water was added to get precipitate which was recrystallized from chloroform. N-ethyl-3-amino indole was synthesized by the treatment of N-ethyl-3-nitro indole with sodium dithionite in presence of (N) sodium hydroxide in ethanolic medium at 50<sup>0</sup>c. The mixture was filtered hot and the filtrate was evaporated to dryness. The residue was dissolved in 5% hydrochloric acid, filtered and made basic with cold 30% sodium hydroxide. The basic solution was extracted with ether and evaporated to dryness. N-ethyl-3-(4,4'-dinitro diphenyl amino) indole was synthesized by the treatment of N-ethyl-3-amino indole with 4-fluoro nitro benzene in presence of cesium fluoride in DMSO solvent refluxed at 120<sup>0</sup>c 20h. The final mixture was stream into (1:1) methanol/water to get the precipitate and recrystallized from DMF/methanol to get crystals. N-ethyl-3-(4,4'-di amino diphenyl amino ) indole was synthesized by the reduction of dinitro intermediate with 10 wt% Pd/C and hydrazine hydrate in the solvent medium of ethanol under reflux at 130<sup>0</sup>c for 15h. After filtration hot, the filtrate was cooled and poured into water. The monomer was filtrated and dried . The synthetic route for the preparation of monomer was represented in scheme-I.



Schem-I

Polymer was synthesized by the treatment of N-ethyl-3-(4,4'-diamino diphenyl amino ) indole with 6FDA at(1:1) ratio in the solvent medium of DMF stirring at 40<sup>0</sup>c for 24h yielding a viscous polyamic acid solution. Then this solution was mixed with acetic anhydride and pyridine and stirring was continued at 100<sup>0</sup>c for 24h. The reaction mixture was poured into methanol to get the precipitate. Indole is electron doner heteroaromatic molecule. Diphenyl amine has also electron donating ability. Thus indole-diphenylamine is a good photoconducting candidate. It is a guest-host system polymer matrix. The polymer matrix can be doped with TNF and photoconducting properties can be measured. The synthetic route of the polymer was represented in scheme-II.



Schem-II

#### IV. Conclusim:

We succeeded in our approach to obtain high Tg polyimide of indole-diphenyl amine moiety. The monomer and polymer were investigated by IR,UV and NMR spectra. Indole-based polyimide exhibited good thermal stability with high Tg and good solubility. This polymer has inherent viscosity and exhibited attractive properties that make it suitable for a variety of applications. Indole-based polyimide generally possess excellent

thermal, mechanical, electrical and chemical properties. Therefore it can be used in many applications such as electronics, coatings, adhesives and composite materials.

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