

Effective Removal of Dyes by Synthesized and Characterized by Anthracene Hypercross Linked Polymer

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Abstract

The preliminary introduction of synthetic polymers in the 1830's is today reflect by an inestimable number of structural variations that have finished in key components in products to rally the requirements of contemporary society. Due to their practical applications in the field of biology, chemistry, and medical field. Hyper cross-linked polymers are of great importance. Synthetic hyper cross-linked polymer will have high surface area with improved pore size and mild operating condition that can be used for amputation of dyes. Hyper crossed linked polymer is synthesized by using Friedel craft reaction used for aromatic network for the formation with highest surface area and microporosity which is suited for the Methane and carbon dioxide even at low pressure and temperature starting from the anthracene and Formaldehyde Dimethyl Acetal (FDA) with different concentration yield highly porous polymers which approximate the separation and Storage for the adsorption of carbon dioxide and methane. This polymer exhibits several elementary properties like that biodegradable property, regeneration property, separation efficiency and high adsorbent capacity. FTIR technique is used to study vibrational energy levels of molecules. As each atom in a molecule or functional group has its unique vibration so they can absorb different wavelength of IR.

Keywords: Hyper cross linked polymer • Families of HCP's • Anthracene • FDA as a cross linker • Removal of dyes (Nigrosine, Purssian blue)

Introduction

Hyper Cross-Linked Polymers (HCPs)

Hyper crossed polymers (HCPs) are the chains of determined micro polymer constituents initially designated by Davankov and have traditional growing research attention. In the preceding few centuries. HCP has developed swiftly due to its astonishing dominance as a variation of synthetic techniques. In physical and morphological inquiry and the limits of promising uses Modest functionalization, huge surface area, little depletion substances and minor operational conditions. Suitable monomer choice, cross linkages of proper lengths and enhanced reaction situations produce a well-built polymer arrangement with modified permeable topology. The advance of networks industrialization enables the presence of several chemical utilities that dominant to fascinating properties and can develop selection for certain uses. To date, various HCPs have been formed using precursors familiar such as polystyrene precursors, external cross-linking approaches, or one step self-condensation. Adventist production of permeable polymers that are accurately well define by means of this technique has refreshed researchers to generate linkages with customer-specific functionality and micromorphology. In reconsideration, we designate not only HCP strategies and simple synthetic principles but also developments in energy and the atmosphere such as catalytic supply of active substances, carbon separation, molecular separation, gas storage, pollutant removal etc.

First oriented hyper cross linked polymer

Hyper crossed interconnected polystyrene was foremost announced in the prompt 1970s [1] and has provoked excessive attention in numerous research

collections in the preceding two eras [2-4]. This attention has been predominantly inspired by some unexpected polymer properties, by their capability to great in non-polar and polar media, irrespective of the thermodynamic similarity of the standard for polymer sorbents or actuated carbon [5]. So far away, hyper crossed polystyrene has been the primary and first one to characterize hyper crossed polymer constituents. Deprived of uncertainty. While various further polymer networks need be capable to have the equivalent precise properties if the development principle is in accord with the principle of hyper cross interconnected polystyrene production. This object deliberates the elementary principles of the development of hyperlinked polymers and displays many specimens for the preservation of hyperlinked material through the procedures of polymerization and polycondensation as well as through crosslinking of lined macromolecules with dissimilar properties. Final materials vary mostly in their enlargement properties from classic polymers with the equivalent chemical properties and necessity be understood as a diverse superior session of hyper cross linked polymers [6]. So far away, hyper cross interconnected polymer polystyrene has remained the foremost and merely one to characterize hyper cross interconnected polymers polymer constituents. Nevertheless, there is no uncertainty that numerous further polymer networks must have the similar precise properties if the development principle is in agreement through the principle of hyper cross interconnected polymers polystyrene production. The elementary principles of the development of hyperlinked polymers besides shows many illustrations for the preservation of hyperlinked flesh over the developments of polycondensation and polymerization as fit as over crosslinking of lined macromolecules with diverse properties. [7].

Hypercrosslinked polymers family

Styrene-divinylbenzene HCPs: Styrene-Divinylbenzene Hyperlinked Worldwide permeable co-polymer Major co-polymerization of styrene with 38% by mass DVB is approved out in the manifestation of one, four and eight dimensions of DCE per monomer size. DVB methods a stiff and tiny linkage since in a linkage of DVB particles instantaneously fit to two polystyrene linkage, which essentially interconnect at this connection when polystyrene co-polymerization with a bulky quantity of DVB arises in the occurrence of a number of liquefied threshold standards that considerably exceed the concentrated swelling of the absolute co-polymer. The surplus solvent distributes in the usage of a micro droplet in a developing tissue. Subsequently eliminating the solvent since the subsequent gel, this field forms a classification of interrelated pores. The proportions of these openings can be comparatively

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bulky in distinction to the micro-pores intrinsic in the compact hyper-bond polymer stage which is shaped in an extremely melted state. Comparable the polystyrene by Super-bond stated beyond, dry styrene-DVB co-polymers are deliberated to tremendous through ethanol or hexane [8].

Hypercrosslinked polysulfone: Polystyrene compared to Hyper-crossed Polysulfone, the Polysulfone recycled in this effort is an additional flexible sequence due to the mandatory of oxygen in its backbone. Processer simulations of the hydrodynamic presentation of unapproachable polysulfone constituent part. Yet, it is also encouraging to achieve hyperlinked associations assembled on Polysulfone by awarding a vast amount of condensed links between chains, which are liquefied in a supercilious solvent, 1, 2-dichloroethane. Initiate a harmless procedure for halogen methylation of aromatic compounds by presenting bromomethyl groups into discretely benzene ring of linear polysulfone. Almost permit by the "self-cross-linking" feedback of the improved Polysulfone is achieved in the manifestation of Friedel-Crafts catalyst, a linkage with a representative of hyperlink configuration. The superficial interior surface region of these polymers and their enlargement in non-solvents is not huge, but they are steady visible and go beyond the experimental inaccuracy of dimension. Two causes can source a minor value of the experimental consequence. On the unique indicator, the advanced conformational elasticity of the polymer sequence and linkage tissue creates it at ease to accomplish thicker chain packing and a smaller amount tense dry tissue development. On the additional indicator, individually sulfone group neutralizes two end-to-end benzene rings, consequently that only the supplementary two rings can contribute in the Friedel-Crafts response. Consequently, not entirely bromomethyl groups can invention a spouse for the feedback. Since of the condensed alteration of functional groups, the material designed is a smaller amount tissue and fewer rigid. Polysulfone are the precursor of polystyrene base play an effective role in modern chemistry which is the new pathway of research [9].

Polyarylates hypercrosslinked: Hyperlinked Polyarylates Two Polyarylates I and II, comprising of isophthalic acid remains and two different bisphenols, are recycled to usage tissue. Polyarylates I macro-molecules have mass-side permutation in bis-phenol components and are consequently supplementary inflexible than Polyarylates II linkage. So, Polyarylates I creates networks with advanced permeability than Polyarylates II, which are interconnected at the identical attention of the primary resolution at DCE. Excitingly, the fabrication of permeable Polyarylates needs much advanced dilution than hydrogenated polystyrene. In universal, lined polystyrene interconnected in the similar solvent outcomes in the development of an extremely absorbent material with observable interior sides. With additional dilution, the hyperlinked polystyrene absorbency variations little. Combined absorbent interconnected Polyarylates swell with heptane, the predecessor intermediate for polymer precursors. Hence, they also fit to the hyperlink polymer lineage.

Hypercrosslinked polyxylene: Hyperlinked Poly xylene this substantial is ready by shrinking p-xylene dichloride in a DCE suspension in the existence of tin (II) tetra chloride. This response primes to hyper-cross compacted solid substantial, the observable innermost surface spreads a very extraordinary significance of 1000 mg, and the flesh expand to toluene, heptane or methanol by cumulative size. In this research we did not discover bulge dependency on concentration standard solution. At primary look, there is no pure reason for this occurrence and consequently advance exploration is required. It necessity be revealed now that the creation of the compression of p-xylene dichloride through anthracene in the stoichiometric proportion indicate a visible innermost surface of 1100 mg and an nearly dual rise in size upon interaction with methanol or acetone.

Other different sorts hypercrosslinked: Further categories of hyperlink linkages can be initiate in the literature, while the biographers did not distinguish the hyperlinked nature of the products attained and did not trial their inflammation in non-solvents. For instance, hyperlinked polymers are frequently ready by considering 4, 4'-dilithiobiphenyl with dimethyl carbonate in tetrahydrofuran. Subsequently slowly heating system to elastic at room temperature, drying and washing, the artifact is cleansed and illustrations the internal surface 1168 mg. The entire opening volume of the artifact is 0.6

cm/g, fairly minor, about 35 Å. This polymer engages (apparently by swelling) up to six intervals the mass of methylene dichloride, while each monomer entity in the series is interconnected. In the occurrence of an acid and surplus water, fluoride catalyst or base, triethoxyl! The purpose of the monomer is hydrolyzed to provide the primary silanol group and formerly the siloxane link. In the condensation development, the preliminary solution of the monomer in tetrahydrofuran or ethanol is transformed from an aryl link which is certain to polysiloxane to a monolithic gel. At first glance, there is no clear reason for this and therefore a preliminary study is needed. It must now be revealed that compression polymers having crosslinking are produced. No symbols of phase parting were detected once the reaction was on going with an acid reagent. Swollen pure gel is then dry with air, previous intermediaries for polymer precursors. This is modest and diverse type of polymer which is characterized by new technique Therefore, they also enter into the hyperlink polymer pathway. In this instance the substantial shaped is called xerogel, which is the characteristic feature of hyper cross linked polymer with porosity structure [10-12].

Hypercrosslinked polymer Structure: The cross-linking polymer obtained during the Friedel-Craft reaction has a solid and porous structure, and its structure cannot be determined using normal analysis techniques such as X-ray diffraction for this purpose using adsorption techniques. Polystyrene precursors are bound to form Hypercrosslinked polymers where adjacent phenyl ring parts are used in two or more special non-planar chain segments, but their length, determined by the degree of polymerization, has a large number of cycles associated with one another for rigid structures. The degree of cross-linking provides information about polar formation, because a more porous structure is suitable for adsorption and pores are formed when swelling and drying. Porosity of structure also plays an important role for hyper-cross-linked polymer functionality, regular aggregation of Nano-particles shows high adsorption capacity, morphology plays an important role for hyper-cross-linked polymer functions.

Nano-structure: Hyper cross linked polymer which are synthesized are converted into Nano range and Nano range is efficient for the potential application, there are many methods have been developed to prepare the hyper cross linked polymer with more uniform particle size their size is reduced below 100 nm. The diameter of hyper cross linked polymer is affected with different pH range. And in some cases the temperature also plays an important role for the reduction in size to obtain a more porous character with high porosity. These Nano spheres are attached with Platinum nanoparticles which are used for the effective catalytic process.

Nano capsules: In hollow cavity of porous hyper cross linked polymer received much attention for the potential application in drugs industries and for many Nano-reactors, the hollow cavity material synthesized on Silicon dioxide, Nano-sized Silicon dioxide particle are synthesized and their shell thickness have great role in the structural activities. Shell thickness mainly handled by the canonization strategy, more the shell thickness more will be the absorption capacity and more will be the surface area for the reactivity. The gas molecules like that Nitrogen dioxide and carbon dioxide mainly absorbed in more concentration in hollow cavity structure. Synthesis of hyper cross linked polymer is a very important topic in many scientific fields through the synthesis of coordination polymers and porous organic polymers, because of the combination of modern properties of both porous and polymeric materials, they are very interesting for research. All these hyper cross linked polymer are synthesize at molecular level with their controlled surface area as well with more porosity character and fine nanotechnology, they can be synthesized with controlled micropore architecture and with controlled micromorphology [13-14].

Solid Phase Extraction Parameter (SPEP)

Three new hyper-bound polymers with a hydrophilic character produced from the hydroxyl residues in them. The framework is made in microsphere format and used for water samples analysis for solid phase extraction of polar compounds. Recovery is different for 1000 ml volumetric samples polar pesticides such as oxyamil, methomyl, selected phenolic compounds and some drugs Ceuticals almost 90%. HXLPP polymers with the best properties are applied to real samples. Its effectiveness is also compared to commercial

sorbents, such as LiChrolut EN (hydrophobic, [hyperlink](#)), macropore) and Isolute ENV+ (hydrophilic, related); New sorbents do commercially available sorbents, which provide adsorption properties [15].

Monolith Solid Phase Extraction (MSE)

Polymer monoliths have been widely studied as particles for sample analysis and porous alternative chromatography technique because of the unique nature of its structural morphology. First, macro-porous structure of highly permeable and allows rapid fluid flow with low back pressure. Secondly, polymer beads have a non-porous core, highly cross-linked to increase dissolved kinetics. In contrast to absorbent powders, where surface surfaces interact deep within particles, monolith interacting surfaces can be accessed with short diffusion distances [16]. Apart from the attractive properties, heterogeneity bed limit the realization of these materials as a highly competitive material for high-performance chromatography applications [17]. In contrast to the chromatographic separation, sample preparation, which seeks analyte binary in this way, is much more less sensitive to the heterogeneous structure of the adsorbent. Porous polymer monolith can offer real advantages in the areas of sample preparation. The first most use of polymer monoliths for this process is done in a column for the extraction of online micro polar organic compounds from water sample. [18]. Use of monoliths polymer for sample preparation currently covers a variety of platforms and applications. However, the breadth of research may be due to manufacturing ease and variety of functional monomers commercially available instead of performance advantages over other technology. Therefore, function, structure of the monolith polymer remains poorly understood, and it takes work enough to really determine their application in the SPE. The monolithic polymers have a lower removal efficiency than that of the particles; the adsorbent bed capacity depends strongly on the available surface area for interaction, where large surface area offer greater analytical sensitivity, monoliths polymer generally poses small surface areas. Although micro and mesoporous are available in monolithic polymer structures, the numbers are significantly smaller than the adsorbent particles of dust. The approach to the production of polymer monoliths with bimodal porous structures, i.e. adsorbents containing macropores for high speed applications and micro and mesopores for large bonded areas, is divided into two distinct categories [19].

Absorbent character and performance

Frontal analysis is used for determining the time of penetration, the behavior of adsorption and the monolithic adsorbents for capacity. The aqueous solution is that has been adjusted up to pH 3 with formic acid. The adsorbent was washed with a solution of methanol using a direct flow. Analyte in aqueous solution is pumped through the adsorbent and the cartridge end is controlled with nm range. Uracil is used as t_0 marker compound to determine the void volume of the system. The absolute Recovery is determined by inefficient extraction method. The solvent and sample are sucked into the syringe barrel with the valve in position 2 and in position 1 syringe valve is removed using a modified needles [20]. Different kinetic models were used for this study, namely the first order pseudo model, the second order pseudo model and the particle diffusion model. First-order pseudo-models usually cannot provide correct data, so basically second-order pseudo-kinetics are used to improve all analytic data. Many number of active sites on surface of adsorption so the kinetic determining speed is determined in the low temperature model of the internal particles.

Characteristics parameter of Hyper- Cross-Linked Polymer (HCP)

Electrical conductivity of hyper-cross linked polymer: Measurements were made for determination of electrical conductivity, this method is also called four point method. In which four electrical contacts were fixed to the flat part of the beads with silver paste, which was split in two. Where two contacts are connected to a closed circuit, power supply with an output 100 voltage, an ammeter/voltmeter and a resistor. Two other electrical contacts mounted on another closed circuit using the same gauge. Measurements were performed at 27°C. Electrical conductivity of hyper cross linked polymer directly linked with parameter of ferocity surface area surface volume more the velocity

character more will be the electrical conductivity of a cross linked polymer, as surface area increases conductivity enhanced, most importantly its parameter related to conductivity are also performed.

Porosity of hyper- cross linked polymer: The specific surface polymer is measured by argon thermal desorption. Total pore volume, was estimated by measuring the volume obtained from 2.00 g styrene gel-0.6% DVB co-polymer beads and 2.00 g of the sample in question (WHP, ml/g) taken. In a glass cylinder measuring 8 mm id. All beads have a diameter of 0.4 to 0.6 mm. Whole pore volume is calculated as $W_o = 0.64 (WHP - W_g)$, where 0.63 is the space packing coefficient for round balls. Repetition of measurement is $\pm 4\%$.

Swelling of polymer (SP): For measuring the water absorption, polymer sample is moistened with acetone and then is removed by stringent washing with water. Excess water is removed by centrifugation at 4000 rpm for 16 minutes and the swollen analyte with water is removed and then dried up to constant weight. The water absorption is calculated as the amount of water retained (ml/g). 2 per g of the dry polymer. The ratio of volume waves is determined by measuring the volume of beads and dry beads (~ 4 ml), which are swollen with the appropriate solvent in 20 ml glass bottle. Repetition of the measurement is $\pm 4\%$ [21].

5 Sorption Properties of Hyper Cross-Linked Polymers (SP-HCPS)

Organic Compound Sorption (OCS): Although the maximum crosslink density, non-functional hydrophobic polymers can absorb relatively large synthetic organic dye molecules, i.e. Malachite green or around methylene blue (MB) (both dyes have the same molecular size. Obviously there are quite large networks and network channels between them the structure of the polymer was investigated, which allowed the migration of bronze green molecules. On At the same time, even the largest tissue for 4.0 nm cytochrome C globules, whose absorption is negligible, cannot be accessed. When attempting to identify unwanted functional carbonyl groups in hyper crystalline polystyrene which is not functioned with high levels of crosslinking through the characteristic reaction of carbonyl with hydroxylamine, we found that the polymer was ready to absorb this polar compound. For example, HP-300 can absorb hydroxylamine (compare with total water absorption).

Mineral Acid Sorption (MAS): The ability of the polymer which has a very high link to absorb mineral acids, salts and bases from the aqueous solution. The highest load is typical. The absorption of mineral acids increases in the study with increasing concentrations of pre-wetting bearings and polymer solutions. Regardless of the density polymer crosslinking and concentration of the initial solution, the acid absorption is reduced in order $HNO_3 > HF > HCl > H_2SO_4 > H_3PO_4$. Retention of acid is mostly determined by fragments interaction, fragments that donate electrons from tissue with protons on one side and the exception of anions greater than the smallest pores on the other side. The strong retention of small HNO_3 molecules is determined by the interaction of H^+ with the components of the arctic network and by the interaction of NO_3^- dispersion ion. In contrast, the phosphate anions are removed from most small pores, and therefore can be ignored retention H_3PO_4 .

Sorption of Inorganic Bases (SOIB): The capacity of potassium hydroxide, ammonium hydroxide while retention comparable even with absorption by the conventional exchange cation resin. NH_4OH sorption isotherms from two hyper cross-linked related polystyrene samples and activated carbon, and carbon-related polymers take up a lot of NH_3 . If the absorption of ammonia cation is caused by its interaction with the aromatic system which accounts for electrons from the material, carbon must offer a stronger absorption site, but will retain less ammonium hydroxide. In fact, its interactions with aqueous NH_4OH are so strong that they swell in solution. The volume of the crossing polymer increases by a factor of 1.7, which corresponds to the swelling in toluene and concentrated hydrochloric acid. It is clear that tissue swelling refers to the absorption of ammonium hydroxide and subsequently facilitates this. With respect to potassium hydroxide, its absorption is low and occurs at the expense of both K^+ cation and OH^- group.

Network of Hyper Cross- Linked Polymer (NO-HCPS)

Conventional type of network: At present it can be said with certainty

that the main type of polymer network represented with styrene co-polymer by DVB. They divided to two major groups. First most group composed of homogeneous network. First of all, it should be nominated here Styrene DVB co-polymer or some other divinyl monomer obtained by process of radical polymerization co-monomer without of solvent. Styrene-DVB co-polymers obtained by this way have been extensively investigated [22]. All modified structures are compared with these tissue properties, consequently this co-polymer is often characterized as standard. Because of their structure, they are called gel-type polymers. Homogeneous structures also include tissue obtained by co-polymerization monomers in the existence of an inert thinner which dissolves the polymer. A necessary condition for the manufacturing of a gel structure in the process in which the use of small amount of solvent takes place. Homogeneous structures of homogeneous cross-linking can also be obtained if the cross-linking bridge is inserted into the network by conversion such as a polymer, for example by chloromethylation of a styrene and DVB cross-linking co-polymer which is crosslinking agent [23]. In styrene co-polymer structure obtained by radical co-polymerization, divinylbenzene connectivity is highly unevenly divided [24,25], which often has an adverse effect on the adsorbent properties based on gel-type co-polymers. Networks with an even cross the bridge distribution can be produced in different ways, such as connecting the firstly formed polystyrene chain, which has a narrowest molecular weight of distribution, use blocks made from polydivinylbenzene [26,27]. Weak. Homogeneous tissue showed nothing porosity in dry condition and therefore be used in an inflated condition. Important to know that this type of structure only swells in appropriate solvents and by that the swelling process decreases down with decreasing in length chain between interconnected points. Group of second consists of heterogeneous structure. Here we have a penetration network [28]. Macro porous structure, latter is obtained by styrene co-polymerization process with extant to bigger amount of divinylbenzene by existence of an inert thinner that dissolve the monomer but growing condition of co-polymer fails [29].

Hypercrosslinked network: In this communication, polystyrene networks are considered, their structure and properties are generally different from those of existing ones known. These structures are referred to as "hyperlinked styrene polymers". Such cross-linking polymers are made by cross-linked linear polystyrene chains in a swollen condition or in solution using bi-functional structures. The cross-linking agent commonly used is p-xylene dichloride (XDC), monochlorodimethyl ether (MCDE). This compound is reacted with a phenyl ring by the Friedel-Crafts reaction. This creates a bridge inside the polystyrene chains. With the exception of diphenyl butane, all connections form bridges with limited conformation mobility in the terminal network. The diphenyl methane bridge has the most difficult structure. Trichloromethyl mesitylene further limits the main mobility of the network by connecting three or more polystyrene chains at one point at the same time. In contrast, there are four consecutive methylene units in the DPB molecule, and thus the conformational rearrangement of the bridge formed by this cross-linking agent is greatly facilitated. This is cross-linked with all of the above cross-linking agents in a solution. In the reaction process, homogeneous solution of components quickly turns into a gel block structure, the volume being slightly reduced compared to the initial volume of the solution. Thus the free solvent is separated in the free phase. After the reaction ends, the swollen polymer structure is smoothed and the catalytic agent is removed by thorough extraction. The polymer produced consists of irregularly shaped particles [30]. The cross-linking polymer obtained during the Friedel-Schiff reaction has a solid and porous structure, its structure cannot be determined using normal analysis techniques such as X-ray diffraction for this purpose using adsorption techniques.

Nature of Cross-linking: The consumption of the cross-linking agent is checked by the reaction ends. First, the product which obtained is analyzed for the possibility of an unreacted chloro-methyl group. However, it was found that they were almost absent in the final polymer. Second, the possibility of cross-linking agents in the solvent separated from the gel during the reaction is determined by thin layer chromatography for crystalline cross linkers (DPB) and CMM) and for gas chromatography purpose DMF and DPB which are very volatile. In all cases, some of unreacted cross-linking agents are absent, by the

exception of DMF and MCDE which are highly volatile. You may be partially in the reactor vapour phase. The IR spectrum synthesized polymers, there are bands which are characteristic of all vibrations of the CH₂ and CH and groups, namely. And phenyl ring. Qualitatively the spectra are identical to styrene co-polymers with p-DVB. There are 830 cm bands in all spectra, which indicate the existence of n-substituted phenyl rings. Strength of that band increases of cross-linking degree of the polymer. The spectrum of products, including those obtained in the ecimolar ratio of bi-functional binding agents and polystyrene and, there is a band of 770 cm. This occurrence is usually due to the vibration of the phenyl group. However, there is no such group. The assignment of 770 cm 'seems difficult, especially given that this band can appear in the spectrum substituted poly derivatives of mono substituted [31].

Hypercross linked network structure: Properties of the interconnected network are very understandable based on the following assumption. The main component element of a structure is a non-planar spatial cycle, which is produced by a network of chain segments and bridges between branch spots. Length of the loop strength is fined by the cross-linking degree and the molecular length of the chain segment agent cross-linking. The formation of structures such as stairs when two l chains are connected by many sequential cross-ties. In polystyrene chains [32]. If the second bridge is formed by vibrational motion of two phenyl rings closest to the bridge, the stress cycle can occur. But in this case, the third ring pair is at a level that completely rules out the formation of a bridge between them. Perhaps the smallest unrestricted ring in the polymer network consists of three or more pairs of adjacent group of phenyl rings belongs to three or more different structure chain or parts and three or more methylene connectivity structures. It is show that larger cycles which are rationalized in the conformation, especially when long chain agents cross-linking are used. It is important to stress that even the small and smallest cycle consists of many number of carbon atoms and may change structure. Which cannot be stored. Rearrangement of large cycle conformations causes significant changes in tissue volume when the polymer dries or swells. Because of their high stiffness, hyper connected structures tend to maintain the most part of volume in which they are produced and which are analyte by slight deviations from the unlined loop shape. Small extent of differences in dissolution energy of polymer structure from bad and to some extent solvents which are good cannot have a significant effect on tissue volume, and therefore swelling of hyperlinked structures in. It is obvious that bigger cycles are also rationalized in network, especially when longest chain agents of cross-linking are used. So it is important to stress that smallest cycle consists of a many number of carbon atoms and can alter conformation. For this network, each cycle is connected, condenses with a many number of some other cycles and cannot be stored, toluene and methanol are practically the same. Only some effects, like that polymer structure drying, can reduce the volume.

Synthetic strategies/methodologies of HCPS

Post-crosslinking method: Example of Hyper cross linked polymer was developed by Tsyurupa and Davankov, where precursors of polystyrene-based such as polystyrene are linearly dissolved or swollen polystyrene-co-divinylbenzene type gel which is cross-linked by an external cross-linking agent (external electrophile) in the existence of an acidic catalyst. And suitable solvents [33]. In general, this type of common process involves two main steps to fully dissolve or swell polymer precursors and intensively cross-link before cross-linking. Pre-synthesis polystyrene chains are distributed together with stoichiometry homogeneously in all solvents and catalysts. The reaction then takes place very quickly and strong bonds of phenyl rings adjacent to rigid bridges in several segments of the chain. This hard connection ultimately keeps the resulting network in limited conformation and does not allow the chain to be mobilized. Or collapse after the release of the solvent. Previously dissolved polystyrene was converted into a one-phase material with a highly porous framework and a low packing density. Common cross linkers so far are halogen containing framework like that bi-functional monochlorodimethyl ether, carbon tetrachloride, Dichloroxylyene.

External crosslinking method: Various strategies have been proposed, including single or cross-condensation hydroxymethyl and chloro-methyl containing monomers to fix the monomers to produce hyperlink polymer

components. All these methods have various limitations. For example, constituents with superior functional groups consistently involve the production of multi-stage organics that contain large amounts of organic solvents and reagents associated with energy costs for the next cleaning stage. Chloro-methyl condensation usually produces chloride of hydrogen, which is dangerous for the environment and production facilities. When Scholl is combined, difficult and difficult reaction situations often increase production time. Therefore, a good plan is still needed for the production of extensive micro-polymers from various simple aromatic building blocks in lighting situations. The knitting strategy offers an innovative approach. Highly active dimethyl acetal (FDA) formaldehyde is recycled as cross-linker to bind aromatic compounds such as benzene to a solid methylene bridge through anhydrous reaction of the FeCl_3 -catalyzed Friedel-Crafts reagent [34]. The following mechanism is proposed, the first-molecular cross-acid catalyst complex which reduces the bond strength between the central carbon atom and the methoxyl group, while carbocacal reacts with the phenyl ring to increase many methoxy-methyl groups into aromatic particles through the release of methanol. These highly dynamic methoxy-methyl collections are changed to methylene bonds when they react with some other phenyl rings to form very tight tissue. Some building blocks of aromatic such as biphenyl, benzene, methyl-benzene, phenol and chloro-benzene, are woven directly, producing a fabric with a large micro and dominant surface. In addition, porous structures and surfaces can be adjusted by changing the ratio of the molar and cross-linking monomers, which in turn affects the degree of cross-linking. When accumulated, the polymeric bonding function can only be converted using aromatic building blocks that contain a large number of these functional groups. Like that, hydroxyl phenolic groups containing polymeric bonds are synthesized efficiently using initial monomer phenol, which shows a 60% increase in CO_2 adsorption compare to other biphenyl knitted polymers with the similar surface area due to increased affinity of CO_2 binding [35].

Knitting method of condensation: To get an extra ordinary high surface area, porous material has a large application in science. Aromatic forming blocks such as biphenyl, benzene, phenol, and chloro-benzene are most often included in the knitting strategy, using additional external crosslinking methods using external cross-linking elements and these high porous materials have high surface properties. Broad and with more porosity. This material has various applications in the field of heterogeneous separation catalysis and is mainly used for gas storage because of its high surface density and low frame density and low chemical stability. Micro-pore organic polymers are synthesized by cross-reaction of aromatic compounds or can be synthesized by trimerization of ethylene or nitrile groups. All of these approaches are used to form poly-micro organic tissue with their pore size and control. This new method includes a knitting process that uses aromatic building blocks with external cross link elements. In this strategy, low-function aromatic compounds are joined together by a single Friedel-Kraft reaction step to produce a porous material. The main external cross linker used in this strategy are dimethylacetal formaldehyde and methanol obtained in this process. As a byproduct in this process, the number of cross linkers used in the samples of both samples varies due to differences in function and reactivity of aromatic compounds to obtain inexpensive products [36].

Direct poly-condensation: One possible application is in the design and synthesis of hyper-bound polystyrene polymers, especially polystyrene complexes used for direct hyperlinking to form commercial polymer products. Polystyrene precursors are condensed using the Friedel-Kraft alkylation agent, and their cell condensation offers good micro characters and stronger structures to strengthen them. The process of self-condensation is only properly investigated after a few modification investigations, as extended aromatic building blocks are chosen to form hyper-cross-linked polymers with higher surface area and bis-characters with high porosity (choromethylantracene). Fluorine-based precursors show nitrogen-based isotherms with maximum surface area [37]. Surface surfaces of hyperlinked polymer control hyperlinked by (DCX) content with pore width w (0.55-1.8) nm using (DCX) content and BCMBP cross bonding elements to bind several heterocyclic structures such as carbazole, alloys with ferrocene metals and building blocks that most rigid (tryptic) [38]. The porosity of the product can be controlled by controlling the length of the cross linker, which is shorter than the cross-linker (DCX), which

offers greater micro capabilities. However, the application (DCMBP) as a cross linker offers a surface larger than $1,650 \text{ m}^2 \text{ g}^{-1}$. For ferrocene polymers, some meso-microspore hyperlink polymers are also synthesized from the Phenom Domain monomer. Because the adjacent aromatic units, which have a very cross-reinforced polymer structure, and several processes involved in the regulation of pores, such as B carbonization, which is a useful application for the adsorption process.

Applications

Past few decades, hyper-bond polymers have developed rapidly in terms of morphological synthesis and control strategies. HCP materials with adjustable permeable structures or superior functions can nowadays be considered at the molecular extent and effectively produced through post-functionalization and co-polymerization with multi-functional building units. With adaptable physical and chemical properties, this HCP material is a favourable candidate for prospective applications in drug delivery, gas storage, molecular separation, carbon capture, pollutant removal, tracking and catalysis.

Storage of gases

Hydrogen is fresh energy source because of its extraordinary superiority as a rich source of high energy density, water use, and environmental friendliness. Hydrogen has the prospect of exchanging additional gasoline and fossil fuels in the future. The individual generation of hydrogen combustion is sea water, and therefore the environmental problems associated with burning fossil fuels can be completely eliminated. In contrast, the slow and safe release/storage of hydrogen release is the main static study. Early studies of hydrogen storage materials consider hydrides of metal, which are limited by energy inefficiencies and slowed kinetics. At present, permeable polymers with a large surface area are being strongly processed because of their size as a selectable additive that is important for hydrogen storage through physisorption. Reversible ability to store and assimilate. On the surface, such permeable materials usually play an effective role in responsible hydrogen adsorption. Materials with extended surfaces always have large amounts of hydrogen adsorption. Size of pore is another significant effect because it not controls relationship between surface size and pore size, but also significantly.

Carbon dioxide storage: Burning fossil fuels generate huge amounts of carbon dioxide, which can influence climate change to limit carbon dioxide. Carbon capture techniques have been developed. Physical adsorption is the best way to reduce carbon dioxide concentration to store and capture carbon dioxide. Hyper-cross linked polymers with micro-pore characters are often used, which can play an important key role in carbon deposition [39]. Different types of solids or carbon dioxide is observed for adsorption, such as Carbonate supported and sorbent supported, adsorption consists of two types, may be physical or chemical in nature, but this adsorption is expensive and less efficient. These types of adsorption are also not effective for carbon storage and capture the use of porous gas storage networks was observed for carbon storage. Various types of micro-pore organic hyperlink polymers are synthesized with micro-pore and their internal morphology. Hyperlink polymers are a family of micro organic substances with large surface area and high surface volume. It has a constant porosity, characterized by internal cross-linking, which, due to its strength and stability, is a hyper-cross-linking polymer of compression, it has high thermal stability and excellent chemical strength, this structure is mainly characterized in the form of monolithic form. Carbon dioxide can be separated before or after combustion. The main reason for the adsorption of carbon dioxide by hyperlink polymers is its surface and volume, larger surface and high porosity ensure sufficient adsorption properties. The carbon build up property is enhanced by the internal cross-linking of hyper-polymeric bonds. Most carbon dioxide is stored at room temperature and low pressure [40].

Hydrogen gas storage: Hydrogen is environmentally friendly due to its abundant form in the presence of H_2O and its high energy density, promises a neat energy source that is capable to displace fossil fuels and gasoline. The main problem with hydrogen gas, however, is the slow storage and release of controls, but for several days now, very micro Hypercrosslinked polymers have been produced due to the large storage capacity and different pore sizes of

hyper bound polymers for hydrogen gas storage for increasing hydrogen gas storage. Gas storage capacity, which has a significant influence on adsorption behavior [41].

The storage capacity of hydrogen gas is increased by first producing nano platinum particles. These nano-particles are contained in hyper-cross linked polymers synthesized in Earlier. The main reason for the synthesis of scattered micro scattered hyperlink polymers is the depletion of fossil fuels, and scientists for global warming are replacing hydrogen gas instead of cellular fuels because of the green alternative. Even at low pressures, hydrogen gas adsorption requires minimal enthalpy, which is carried out at room temperature [42].

Methane gas storage: Natural gas, which consists mainly of methane, will have many prospects as an unconventional oil in the future because of its rich causes, low cost and relatively safe effect on the environment. However, safe and inexpensive storage of superior gauges and measured discharges are problems that are considered statically when realizing the actual potential for energy generation. An approach such as hydrogen is the physisorption of methane in a carrier with superior pore volume and surface area. The size of qualitative adsorption is analogous to various additional micro-pore structures, so there is not enough resources for larger micro-pores such as MOF. Conversely, permeable polymers consume clear advantages because they can be made as continuous monoliths. The unit recommends possible ways to overcome volume problems associated with powder packaging. For now, porous dampers are far from reaching DOE goals and meeting requirements for practical use.

Removal of micro pollutant

Hyper cross-linked polymers are hydroxihydroxy in structures with a hydrophilic character, showing a stronger effect for removing polar impurities from aqueous samples. Recovery of polar pesticides such as oxygen, methomyl and some phenolic groups. Because of their hydrophilic nature, they are successfully applied to samples. Solid phase extraction is the best technique for removing micro-pollutants from water before using sorbent based layers. Because the porous absorption characteristics of the polymer that are connected to the compound, are fully marked, so that the character of prosperity is directly related to the effectiveness of the sorbent. Most commercial sorbents available on the market are based on styrene, they have a hydrophilic and micro structure so that they are effective for non-polar compounds and then increase the surface for polar compounds to increase the retention of polar compounds. Sorbents for absorption.

The hyper-cross-linked resin is the best resin to increase hypophilicity from hyperlinked polymers, for example. Some co-monomer additives are carried out for hydrophilicity, hydroxyl groups play an important role, which can increase the absorption process, because hydrophilicity is present for the absorption process and small particle size is very important, so many hyperlinked polymers with hydroxyl groups are synthesized in the framework and when used in real samples such as mineral water, tap water and river water, this process evaporates the height to increase the sensitivity of the water sample. Evaporation occurs under a dry stream [43]. HCP has long been used as a solid absorbent and is widely used in Solid Phase Extraction (SPE), wastewater treatment, organic vapour adsorption, as well as in chromatographic analysis and others. Because of its abundant narrow microspore, adsorption in HCP is not only a classic surface phenomenon, but adsorption molecules are also transferred from the surface to the internal macropores through channels. As a result, the adsorption capacity and adsorption rate increase significantly. In addition, HCP materials with hydrophobic backbones have a stronger affinity for organic molecules and show promising potential in water treatment compared to conventional inorganic materials such as activated carbon [44]. A new polymer with a hydrophilic character, derived from a 2-hydroxyethyl methacrylate monomer, is produced in the form of microspheres. With a large specific surface area and a moderate level of hydrophilicity, polymer absorbents show a high regeneration of 90% for various polar compounds such as oxyamil, methomyl, phenol compounds [45].

Effective adsorption

Some metals are very toxic and dangerous to health and occur in humans

and other living organisms because they exceed their tolerance limits [46]. Many techniques such as coagulation, ultrafiltration, adoption. All of these methods are often used to remove toxic metals. However, the most economical method is adsorption to remove contaminants from water. This method is more efficient and economical even at low concentrations [47]. Because of its large volume, large surface area and fine porous nature, it is effective for interchangeable ions. It is necessary to compare pore sizes and adsorbent sizes. Some conventional micro-porous adsorbents such as carbon and zeolites are used as harder micro-pore absorbents because of the structure of soft organic porous polymers in accordance with point technology [48].

Removal of volatile organic compound

Volatile organic compounds not only cause air pollution. The adsorption process allows volatile organic compounds to be extracted efficiently from industrial waste for this purpose. Hyperlink polymers are made because of their specific porous properties and large surface area. Polymers that have hyperlinks, due to their specificity, can remove volatile organic compounds from the physical and chemical properties of waste. In recent years, they have been used as adsorbents to eliminate air pollution. Emissions of volatile organic compounds with hyperlink polymers effectively control their activity in industrial wastes and a practical adsorption system is used [49]. Polystyrene hyper crosslinking polymer monoliths is obtained by a knitting strategy in which the emulsion is polymerized in a deep phase, hyper crosslinking is performed in the presence of dimethyl acetal formaldehyde (FDA) as cross-linking agent, the most obvious confirmation of by Scanning Electron Microscope (SEM) hyper-cross-linked polymer obtained, which confirms the structure with the original monolith, which is maintained in the nail strategy [50].

Separation by chromatographic techniques

Hyper connected monolithic capillary columns with a series of small holes are ideal for highly efficient isocratic detachments [51]. In recent decades, the efficiency of capillary polar adsorption for many light organic particles and large biological particles such as alkyl benzenes and proteins, their derivatives, phosphopeptides. For and uracil. For example, permeable polypore monoliths (styrene-divinylbenzene) made from hyperlink monolithic pre-reactors by Friedel-Craft reactions catalyzed by FeCl_3 using three external cross-links, including the FDA, DCX and BCMBP, the upper surface created using BCMBP - Get tissue. Capillary columns containing hyper-cross-linked monoliths are returned as solid steps for liquid chromatography, after which they significantly increase the phase separation competence of the combination of six alkyl benzenes and acetone. With accumulation, a relatively very useful efficiency is achieved. Another approach has been developed to make permeable polymer monoliths through large surface spaces [52].

Uses in drug delivery

Cross-bond polymers with typical morphological properties that contain free structures are also micro-structured, abundant as storage materials at the same time offer the route needed for the operation of the measured extraction/release system. Examination of drug loading and hyperlinked polymers measures the aid properties which indicate the entry of the drug into the hyperlinked polymer cavity. Drug release is achieved by immersing a hyper-cross-linked polymer that is loaded in the drug in a replicated liquid. When comparing drug release behavior from a number, it was found that the permeable projectile design significantly affected the drug release kinetics. Hyper-cross polymer bonding with reciprocal meso and hyper-cross-linked polymer organization shows a fixed first-order kinetic prototype, which shows that the release device is mostly measured by easy diction, except that the release rate is proportional to the drug residue in cavity [53].

Process of sensing

Sensor of electrochemical humidity is produced. Using many building blocks with 3-hydroxybenzoic acid. Even with carboxyl groups and rich hydroxyl, sensors are made from pure polymers which do not exhibit any visible impedance changes until air humidity reaches 55% relative air humidity. To improve the properties of hollow polymers hydrophilic nature. Lithium improvement was proceed by using LiCl salts, where interactions between the material and water molecules were increased [54].

Catalytic activity

Heterogeneous catalysis plays an effective role because of its ease of use and high recycling [55]. Because of the long diffusion pathway, their selectivity and efficiency slow down compared to homogeneous catalysis. For this purpose, suitable materials that can offer a very responsive interface. Therefore, hyperlink polymers are used more frequently and more efficiently for heterogeneous catalysis because of their large pore volume large and surface area [56]. For this purpose, some modifications require the production of organometallic catalysts by inserting radial ions in hyperlinked tissue. The material entered has the largest surface and active area of the process with high tissue dispersion [57]. The resulting porous polymer works both as a carrier and as a catalyst protector [58]. Several hyperlink aryl co-polymerization polymers are used directly to support rhodium-based catalysts, producing heterogeneous catalysts with high activity and specific effectiveness that are most effective than silica-based catalysts that are incorporated into aryl knitter networks [59]. For selective oxidation of olefin-activated phosphomolybdic acid, to form epoxides from olefin oxidation [60]. This type of catalyst and its selectivity and activity, obtained by using reaction medium ethyl acetate, reduce its activity when acrylonitrile media is used. This type of polymer is achieved through a co-polymerization process [61]. Pure, heterogeneous, active organic catalysts with visible light are often more suitable than metal-based catalysts. The hyperlink polymer circuit is a porous organic polymer containing a photo active conjugated base and added to heterogeneous catalysis. This micro-pore structure is obtained by linking organic semiconductor compounds using the Friedel-Craft reaction. This micro-structure is obtained by precisely defined porosity and surface volume, which can be used for word photo-catalysis. In recent years, some precious metals such as platinum, palladium, rhodium and some base metals have been used for active catalysis because of their weaknesses related to the process of catalyzing metal bases with high cost and high toxicity, but in recent years with UV Light widely used for respond to chemical transformations as alternatives and types. The eastern micro porous structure of hyperlinked polymers has increasingly attracted attention lately. They contain a number of building blocks of aromatic conjugated compounds which are carried out by simple Friedel-Craft reactions. The resulting micro-linking polymer produces friedel-Craft reaction in the existence of catalyst Friedel-Craft. [62].

Synthetic dyes

Synthetic dyes are mainly applied in different industries such as paper, textiles, rubber, leather etc. About 10-15% of the dye is discharged into wastewater during dipping. Wastewater is main cause to produce one ton of end products of the textile industry. Due to the toxicity of azo dyes and complex aromatic structures, water from textile waste cannot be treated effectively with conventional methods such as bio-degradation, bleaching, ozonation and electrochemical technology. Therefore it is very important to find a good method for the dye extraction process. The current alternative candidates are pressure-controlled membrane technology, which replaces conventional methods due to relatively lower investment, lower energy costs, greater selectivity and favourable working conditions [63]. Beside membrane technologies, it has been shown that nano-filtration membranes offer high dye repellency when applied to dye wastewater treatment [64]. However, available commercially membranes that are produced by the process of interface polymerization have relatively low water permeability and therefore require relatively higher operating pressure to maintain the flow, which leads to increased energy consumption and the potential to further prevent its use [65]. Many approaches have been conducted to study the possibility of using ultra-filtration membranes for treatment of textile wastewater due to their high content Flow seepage. However, normal dye rejection is not enough for the dye recovery, because a large amount of dye flow through the hollow membrane [66]. A new type of porous fiber composite is produced by reaction of aqueous HPE emulsions and GA cross-linking agents on a PVC-UF substrate membrane. The experimental results show that a dense, relatively smooth and hydrophilic HPE skin layer has successfully formed on the surface of the PVC-UF useable membrane. It showed that the performance of the resulting composite membrane is remarkably affected by manufacturing conditions cross-linking agent the concentration [67].

Experimental work

Equipment

Lab balance: Analytical balance (often referred to as "laboratory balance") is a class of equilibrium for measuring mini masses in range of sub-milligram. Analytical balance pan measuring (0.1 mg) is located in a translucent housing by a door so no molecule of residue is gathered so all wind stream in the room doesn't meddle with the activity of the equalization. This housing is often referred to as a label. The use of a mechanically ventilated protective housing with a uniquely designed acrylic wing allows even air flow without turbulence, which prevents balance and mass fluctuations of up to 1 μg without vacillations or product loss. Additionally, the sample must be at room temperature to forestall regular convection due to the formation of air currents in the case without causing reading errors. The unique mechanical replacement balance sheet maintains a constant reaction all through its helpful limit, which is accomplished by keeping up a consistent load on the equalization beam and in this way the reference point by diminishing the mass of the side of the beam equivalent to which the sample was included. Electro analytical parity quantifies the power expected to neutralize the deliberate mass, instead of utilizing the genuine mass. In this way, they should have calibration settings to make up for the distinction in gravity They use electromagnets to create opposing forces on the measured sample and issue the results by estimating the power expected to accomplish equilibrium. Measuring devices like that are called sensors to restore the electromagnetic force. With this instrument, the mass of the sample is determined precisely and precisely up to 0.1 mg. This is an expensive and complicated tool. It is impossible to carry out quantitative analysis without the help of analytical balance. Because each experiment is carried out with a certain sample weight and different chemicals, which is only possible with analytical balance.

Filter paper: It is used for the separation of suspended particles from liquid. It permits pure liquid to pass out through tiny pores present on it. It is a physical filtration done for removal of undesired components from liquid. Unwanted material which is left on paper is known as residue. Obtained material after filtration is termed as filtrate. Filter paper can be mainly classified into two main terms:

- Qualitative filter paper
- Quantitative filter paper

Magnetic Stirring in Lab: Magnetic stirrers are devices that are extensively used in laboratories and comprise of a stationary electromagnet or spinning magnet that yields a rotational magnetic field. With that device, for example, a mixer is produced, immersed in liquid, stirred or stirred or the solution is stirred. Magnetic stirring systems usually consist of a heating system that is connected to heat the liquid. Most magnetic stirrers today turn on magnets with electric motors. This kind of apparatus is one of easiest mixes to make. Magnetic stirrers are silent and offer the possibility of mixing closed systems without insulation, as do mechanical stirrers. Because of its size, the stirring rod can be washed and purified more simply than new apparatuses such as a stirrer. Conversely, the limited stirrer size only allows this system to be used for volumes smaller than 4 liters. In addition, this process hardly mixes thick liquid or solid solution. In this case mechanical stirring is usually required. Stirring comprises of a magnetic adhesive tape recycled to mixing a mixture or fluid solution. Since glass does not considerably influence the magnetic field and supreme of the biochemical reaction yield in beakers or glass bottles, moving the stalks in glass vessels, which are frequently used in research laboratory.

Characterization/ Analysis: Various types of techniques are used to mark the final product contained.

- Ultraviolet/Visible Spectroscopy (UV-VIS)
- Infrared Spectroscopy (IR)
- Fluorescence Spectroscopy (FS)
- Nuclear Magnetic Resonance Spectroscopy (NMR)

- Scanning Electron Microscope (SEM)

Ultraviolet/Visible spectroscopy

UV visible spectroscopy is an analytical technique used in chemistry, which is based on interaction of matter with light spectroscopy, where dissolved molecules are molecules in the gas or liquid form can be measured with absorption of light, light ranges between 200 to 800 nm, below 200 nm known as vacuum ranges, about a 100 to 400 nm is called UV Spectrum range, range from 400 to 800 nm light in the visible region. The basic principle of UV visible spectrum spectra is that molecules absorb electromagnetic radiation and UV visible spectrophotometer show absorbance at each wavelength the UV and visible spectrum have smaller wavelength as compared to the IR spectroscopy. The Spectra is attained by the amount of light captivated at each wavelength emerged due to excitation of bonding and nonbonding electron in a molecule. The molecule of combination of first be absorbed the light and get excited and then come back to ground State gives the energy which of these in the form of light and recorded.

Principle of absorption: The beam of light coming from the source divided into two rays one of them managed through the specimen to be examined other than focused concerning the cell comprising a solvent taking a zero. Solvent should be transparent so that the comparison could made the instrument scan intensities of both (solvent and Sample) over the range of wavelength it follows the rule of Lambert beer law.

Applications: Transition metal ions Solutions can be colored (i.e., absorb visible light) since d electrons inside the metal atoms excited from one electronic state to additional. The colored metal ion suspension is strongly stimulated by the occurrence of other types, such as definite ligands or anion. For illustration, the colored dilute solution of copper sulfate is a light blue; addition ammonia intensifies color and variations the maximum absorption wavelength (λ_{max}). Organic mixtures, particularly those with a extraordinary degree of conjugation, similarly absorb light in the UV or visible states of the electromagnetic spectrum. The solvents for these purposes are frequently ethanol for organic-soluble compounds, or water for water-soluble compounds. (Organic solvents may have important UV absorption; not all solvents are appropriate UV spectroscopy).

Fourier-Transform Spectroscopy (FT-IR)

The measurement technique in which the spectrum is gathered dependent on the measurement of the radiation of coherence source using measurements in the temporal or cosmic range of radiation of electromagnetic or other types of radiation. It tends to be utilized for different sorts of spectroscopy, including electron spin resonance spectroscopy and mass spectrometry, infra-red spectroscopy, optical spectroscopy, magnetic resonance spectroscopy and magnetic resonance imaging. There are a few strategies for estimating the light of temporal coherence including Fourier continuous wave spectrometers and Fourier transform spectrographs. The word Fourier transform spectroscopy reveals the detail that entirely of these performances involve Fourier transforms to adapt raw facts into definite spectra and in numerous cases develop optics with interferometers.

Measuring an emission spectrum: Utmost fundamental tasks in spectroscopy is to describe the range of a light: amount light emitted at diverse wavelength. The facile means to compute spectrum is to permit light over a monochromator, an appliance that obstruct all light excluding light of a definite wavelength.. The intensity of the residual light (single wave) is then computed. The computed intensity displays directly at this wavelength how considerable light is emitted. The whole spectrum can computed by varying the monochromator wavelength situations. The entire spectrum can be measured by changing the monochromator wavelength settings. This simple diagram actually illustrates the workings of several spectrometers. Spectroscopy of Fourier transform is a little intuitive technique for attaining the identical data. As an alternative of transient one wavelength at an interval to the detector, this machinery diffuses a ray that comprises many diverse wavelengths of light at the equivalent time and compute total beam intensity. The beam is modified to comprise a mixture of diverse wavelengths, manufacturing a subsequent data fact. This mechanism repeats many times.

Measuring an absorption spectrum: The spectroscopy of Fourier transform method can also be utilized for spectroscopy of absorption. Main example is "FTIR spectroscopy", a method that is common in field of chemistry. In wide-ranging, the determination of absorption spectroscopy is to compute the degree to which a specimen transmits or absorb light at each diverse wavelength. While emission and absorption spectroscopy are usually diverse, in preparation they are thoroughly related. Slightly emission spectroscopy procedure can used for absorption spectroscopy. First, the broadband light emission spectrum is computed (this is called the "background spectrum"). Second, compute the emission spectrum of the identical lamp that shines through the specimen (this is termed the "sample spectrum").

Scanning Electron Microscope (SEM)

The electron scanning microscope is a kind of electron microscope which creates sample images by examining surfaces with concentrated electron beam. Electrons interrelate with the atoms in the specimen and yield numerous signals that comprise details approximately composition of the sample and the surface topography. The beam of electron is scanned by the raster scan and the beam position is combined with the detected signal intensity to produce image. In the utmost collective SEM approach, secondary electrons released by atoms which are excited by the electron beam are noticed by a secondary electron detector. The quantity of secondary electrons that can be detected and consequently the signal intensity dependent on the topography of the specimen. SEM can extent the resolutions more than 1 nanometer.

Principles: In scanning electron microscopy signal which is used to obtain images is the result of the interaction of electronic beams with different atoms in the sample at different depths. Various types of signals are generated, including secondary electrons, reflected or scattered electrons, X-rays and characteristic light, absorbed current and transmitted electrons. The detectors of Secondary electronic are standard tools in all SEMs then it is exceptional for apparatus to have a sensor for entirely other conceivable signals Secondary electrons poses very small energy in the range of 50 eV, which bounds the usual free route in solid substance, which implies that pictures can be recorded on the outside of the sample with a solution beneath 1 nm. Back scattering electrons are electrons beam that are returned in specimen with flexible scattering. They originate from a deeper point in the specimen and therefore image resolution is inferior beside SE images. Conversely, back scattering electrons frequently used in analytical SEM across with spectra formed via characteristic X-rays since the intensity of back scattering electron signal is thoroughly linked to atomic number (Z) of the specimen. Electron pictures with scattered backgrounds can offer details around the distribution, even not about identities of various elements in the specimen. In specimens consisting mainly of elements of light, like as bio samples, the scattered electrons can represent immunity markers of colloidal gold with a diameter of 6 or 11 nm which would somehow be troublesome.

Transmission Electron Microscopy (TEM)

A microscopic technique by which a beam of electrons is pass through a sample to make an image is called microscopy of transmission electron is. Most of the samples are ultra-thin parts with a thickness of less than 100 nm or a lattice suspension. The image is created by the collaboration of electrons with the sample when light is pass through the sample. The picture is then enlarged and targeted on imaging devices like as neon screens, photographic film layers. A microscope of transmission electron can produce images with a lot high resolution than a light microscope. In that way, the apparatus can capture subtle details as little as a column of single atomic that is a thousand times little than the object that can be divided that is seen in a light microscope. The microscopy of Transmission electron is a fundamental analysis way in physics, chemistry, and biology. Then are used in virology, cancer research, and nanotechnology and material science as well as in semiconductor research and pollution, but also in other fields such as pale ontology and palaenology. The TEM instrument has various modes of operation, including conventional imaging, TEM imaging, diffraction, spectroscopy, and a combination of both. Even in conventional images, there are many very different ways to create contrast, which is called the "image contrast mechanism". Contrast can result from differences in positions in thickness or density, atomic number (based on

the abbreviation Z total for atomic number), crystal structure or orientation as well as slight changes in the quantum mechanical phase produced by each atom in the electrons that pass through it. The energy lost by electrons when passing through a sample.

Lab oven

Laboratory furnaces are furnaces for bulky dimensions' heat convection uses. That ovens usually produce the same temperature. Process uses for laboratory ovens can be used for sterilizing, annealing, making polyimide, drying and for further engineering research laboratory purposes. Usual sizes range from cubic foot to 0.10 cubic meters by temperatures that can exceed 350 degrees Celsius. Laboratory furnaces may be used in a many of configurations and applications, including natural convection, clean rooms, inert atmosphere, forced convection, horizontal airflow and pathways. Some of the industries where laboratory ovens are commonly used are the health, transportation and technology. Construction laboratories ovens use to dry out asphalt, soil, stone or concrete samples and many more.

Glass ware

Glass wares (flask, pipette, test tubes, beaker, conical flask etc.). Glass made sample bottles and plastic vials used. Before using washed off all the operators three times with water to remove the contamination and impurity. After washing placed all the glassware in the oven for drying at 40 to 50 degrees save all the glass and plastic in closed packing.

Research Methodology:

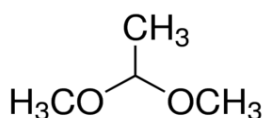
The cross-linking polymer previously synthesized from polystyrene based precursors uses a cross-linking agent which is suitable for the presence of Lewis acid as a catalyst and uses a suitable solvent. This process occurs in two steps, in the first process a complete dissolution of the pioneers occurs and in the second process there is an intensive network. In this process, polymer precursor polymers are completely dissolved in solvents with double stoichiometric cross linkers and catalysts, the process continues rapidly and causes strong binding of adjacent phenyl groups, and the binding process leads to limited confirmation of tissue for dissolution and mobilization after removal to avoid removal. Porous framework derived from solvents with low packing density and with high porosity polymers. These different networks with different connection units, for example with length and stiffness that changes.

Chemicals required

- Cross linker (Formaldehyde Dimethyl Acetal)
- Catalyst (Ferric Trichloride)
- Solvent (Dichloromethane)
- Aromatic Monomers (Derivative of Benzene Ring)

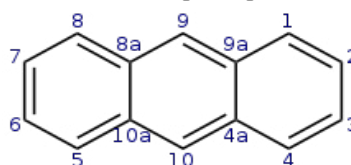
Chemistry of Formaldehyde Dimethyl Acetal (FDA)

Formaldehyde Dimethyl Acetal, similarly called methylal, is a dreary burnable liquid with a low breaking point, low consistency and incredible dissolving power. It has a chloroform-like smell and taste is impactful. It is the dimethyl acetal of formaldehyde. Dimethoxymethane is dissolvable in three segments water and miscible with most standard characteristic solvents. It could be made by oxidation of methanol or by the response of methanol with formaldehyde. In watery destructive, it is hydrolyzed back to methanol and formaldehyde. Due to the anomeric sway, dimethoxymethane has a tendency toward the dishonourable consistence concerning all of the C–O bonds, as opposed to the counter transformation. Since there are two C–O, since it is maybe the most diminutive iota showing this effect, which has exceptional premium in sugar science, dimethoxymethane is consistently used for speculative examinations of the anomeric sway.



Chemistry of anthracene

Anthracene is a strong polycyclic sweet-smelling hydrocarbon of equation $C_{14}H_{10}$, comprising of three intertwined benzene rings. It is a part of coal tar. Anthracene is utilized in the creation of the red color alizarin and different colors. Anthracene is drab yet displays a blue (400–500 nm top) fluorescence under bright radiation. Anthracene is a strong polycyclic sweet-smelling hydrocarbon of equation $C_{14}H_{10}$, comprising of three intertwined benzene rings. It is a part of coal tar. Anthracene is utilized in the creation of the red color alizarin and different colors. Anthracene is drab yet displays a blue (400–500 nm top) fluorescence under bright radiation. Numerous examinations demonstrate that anthracene is no carcinogenic: "reliably negative discoveries in various *in vitro* and *in vivo* nontoxicity tests". Early tests recommended in any case since unrefined examples were debased with other polycyclic fragrant mixes. Besides, it is promptly biodegraded in soil. It is particularly vulnerable to debasement within the sight of light.



Synthetic procedure

To synthesize hyperlink polymers, monomers of aromatic compounds are treated with alkylating agents such as these alkylating agents from Friedel craftsman in the presence of suitable dimethyl acetate formaldehyde cross linkers. This mixture is heated to 45 degrees Celsius for 24 hours and minutes, after the temperature is lowered, it settles and deposits are collected by the screening process, and unwanted residual monomers are removed by washing the crosschecked polymer with methanol. And then a cross-linked polymer is obtained which is dried in the vacuum using a vacuum drying agent. One-step condensation is a cross-linking process in which previously synthesized selected precursors condense in the presence of alkylation in radical polymerization reactions, the most commonly used precursors are polystyrene precursors in which condensation itself occurs and has hardness and function of porous polymers and in this process we using many network elements.

Crosslinking of anthracene

Anthracene is cross connected by utilizing formaldehyde dimethyl acetal As a cross linker for this reason we utilize dissolvable 1, 2-dichloroethane are dichloroethane which are most appropriate dissolvable for crosslinking of Anthracene The entire reaction is set for 19 hours on a hot plate with Stirrer. Until a thick glue is framed which is the sign of arrangement of hyper cross-connected polymer in profoundly consolidated structure.

Step 1: In first step first of all we take 10 ml solvent 1, 2- dichloroethane and then we add 0.3 gram Anthracene as a monomer and then we add formaldehyde dimethyl acetal as a crosslinker for crosslinking purpose then we add 0.3 gram powder of iron trichloride ($FeCl_3$) which act as a catalyst and mix thoroughly in round bottom flask.

Step 2 : In second step round bottom flask put in oil bath and fit the condenser to the round bottom flask purpose of condenser is not to evaporate the solvent which is a medium for the for this reaction.

Step 3: In third step the whole setup placed on hot plate first maintain 45 degree centigrade for 5 hours for condensation of monomer and then placed 14 hours for 80 degree centigrade the whole reaction is maintained for 19 hours until the product formation takes place.

Step 4: In 4th step the product which is formed actually a thick paste filter with filter paper the Residual amount then washed with methanol and the Residual product is fully refined until the colour of iron trichloride diminished. In final step Residual amount collected in China dish and then placed in oven for 80 degree centigrade until the product is dried. The product which is obtained in final process will be grinded in finely divided form, this product of hyper cross linked polymer Which is go through to the different analysis such a

as ultraviolet spectroscopy and Fourier transform spectroscopy, scanning electron microscope.(Tables 1 and 2)

Result and Discussion

Physical properties of hyper cross linked polymers

Analytical studies of hyper cross linked polymer: Hyper cross linked polymer of Anthracene which are synthesized in this work w characterized by ultraviolet spectroscopy and Fourier transform spectroscopy.(Figure 1 and Table 3)

UV studies: To determine the Ultra violet spectra of the Anthracene and Anthracene HCP. The Carry 60 UV-visible (Agilent technologies) present in the Chemistry Department of UET, Lahore was used.

1. The maximum wavelength λ_{max} of the Anthracene was observed at 450 nm
2. The maximum wavelength λ_{max} of the Anthracene HCP was observed at 365 above.(Figure 2)

FTIR: The synthesized hyper cross linked polymer were also characterized by using FTIR scan. To obtain Infra-red spectrum of synthesized hyper cross linked polymer of Anthracene, Carry 630 FTIR spectrophotometer, present in

Chemistry Department of UET, Lahore was used . They range available on this spectrophotometer was 650-4000 cm^{-1} (Figures 3 and 4)

Scanning electron microscopic technique used to reveal the internal diameter of any particle. By the use of scanning electron microscopic technique, the structure of hyper cross linked polymers demonstrated porous and non –crystalline morphology. These structures constitute pile of tiny globular particles. In addition to porous structures of hyper cross linked polymer, also shows the morphology like agglomeration of blended large particles. The images obtained via scanning electron microscope exhibited globular morphology with plane surface. The width of internal diameter of hyper cross linked polymer is 2 micrometer which is revealed by scanning electron microscopic technique. The small internal diameter is the acquired feature of hyper cross linked polymer which revealed unique morphology and porous surface of hyper cross linked polymers (Figure 5).

Applications

Dyes removal

Preparation of dye solution: Firstly 5m g of the dye (nigrosine, methyl blue or acid orange 74) was dissolved in 50 ml of pure water. After that this solution was moved to 100 ml volumetric flask and pure water was added into

Table 1. Physical properties of cross linked polymers.

Name of Compound	Color	Physical State	Melting Point
Anthracene	White Crystal	crystalline	80.28
AnthraceneHCP	Brown Red	crystalline	800 above

Table 2. Showing solubilities of hyper cross linked polymer.

Solvent	Anthracene	Anthracene HCP
Benzene	Soluble	Insoluble
Chloroform	Soluble	Insoluble
Water	Insoluble	Insoluble
N Methyl Tryptamine	Soluble	Partially Soluble
DMF	Soluble	Partially Soluble



Figure1. Resultant product.

Table 3. Dyes removal.

Dyes	Original Color	Color of Filtrate
Methyl blue	Bright greenish blue	Colorless
Nigrosine	Black	Colorless
Acid orange 74	Dark green	Colorless
Prussian blue	Black or dark blue	no change of color

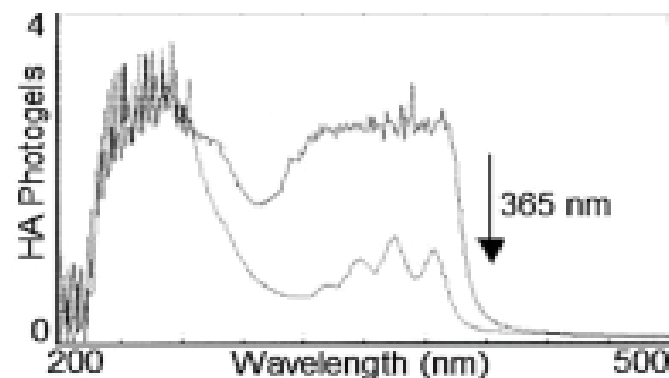


Figure 2. Fourier transform infrared spectroscopy.

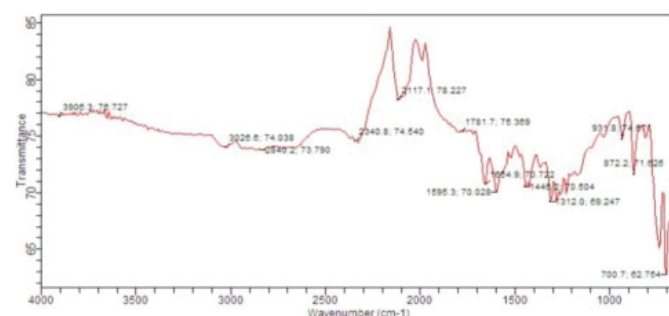


Figure 3. Sample 1.

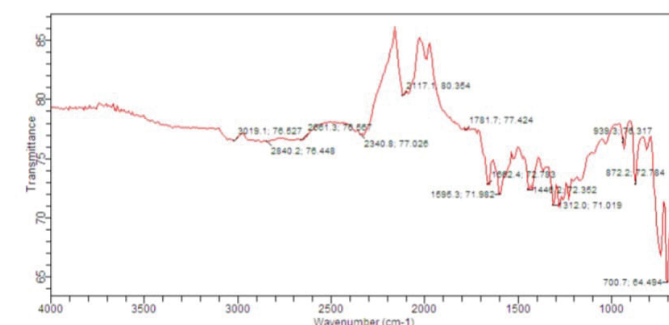


Figure 4. Sample 4.

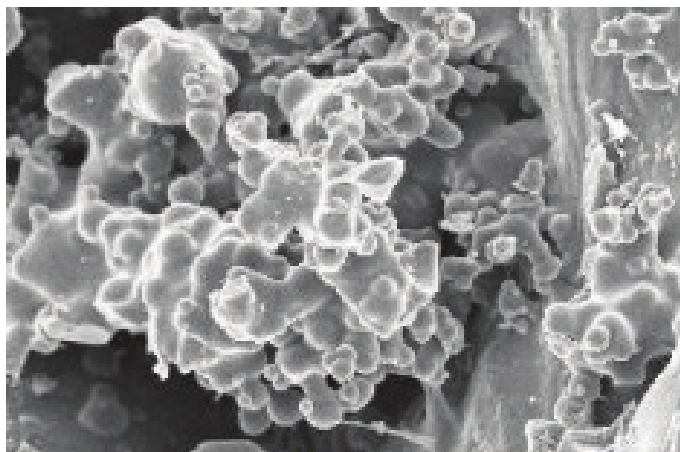


Figure 5. Scanning electron microscope.

the flask until the trick mark reached. After that took 10ml of freshly prepared dye solution moved it into 20 ml glass vial. Then 60mg of HCP nanoparticles were added to the dye solution. Then sealed the vial and shocked violently for 5 minutes. After shaking, vial was kept for 5 minutes. The color of dye solution started turned to be fade. Because HCP hydrophobic and have low density for that reason, almost all nanoparticles started float on the surface of solution. Finally the mixture was filter and the filtrate was collected. Then compared it with untreated dyes. This has shown that filtrate of dye solution were cleared and colorless then other ones. Which shows that dyes were completely eliminated by HCP nanoparticles in a short time approximately 15 minutes.

In case of Prussian dye: The Prussian blue solution with the same procedure was experimented which shows that the color of filtrate of Prussian blue is not as much faded as compared to other filtrated dyes solutions. Which indicated that Prussian blue was not adsorbed on HCP nanoparticles and there was still much quantity of Prussian blue left in solution.

Reason: As from the structure of filtrate dye show that they contain benzene rings in their structure and Prussian blue did not have benzene ring. Its shows that HCP nanoparticles containing many benzene rings exhibited rapid and selective adsorption towards the dyes containing benzene ring.

Reactivity order of HCP nanoparticles:

Anthracene>naphthalene>xylene>toluene>benzene

Conclusion

Hyper crossed linked polymer is synthesized by using Friedel craft reaction used for aromatic network for the formation with highest surface area and microporosity which is suited for the Methane and carbon dioxide even at low pressure and temperature starting from the anthracene and formaldehyde dimethyl acetalswwwa (FDA) with different concentration yield highly porous polymers which approximate the separation and Storage for the adsorption of carbon dioxide and methane. This polymer exhibits several elementary properties like that biodegradable property, regeneration property, separation efficiency and high adsorbent capacity. FTIR technique is used to study vibrational energy levels of molecules. As each atom in a molecule or functional group has its unique vibration so they can absorb different wavelength of IR.

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