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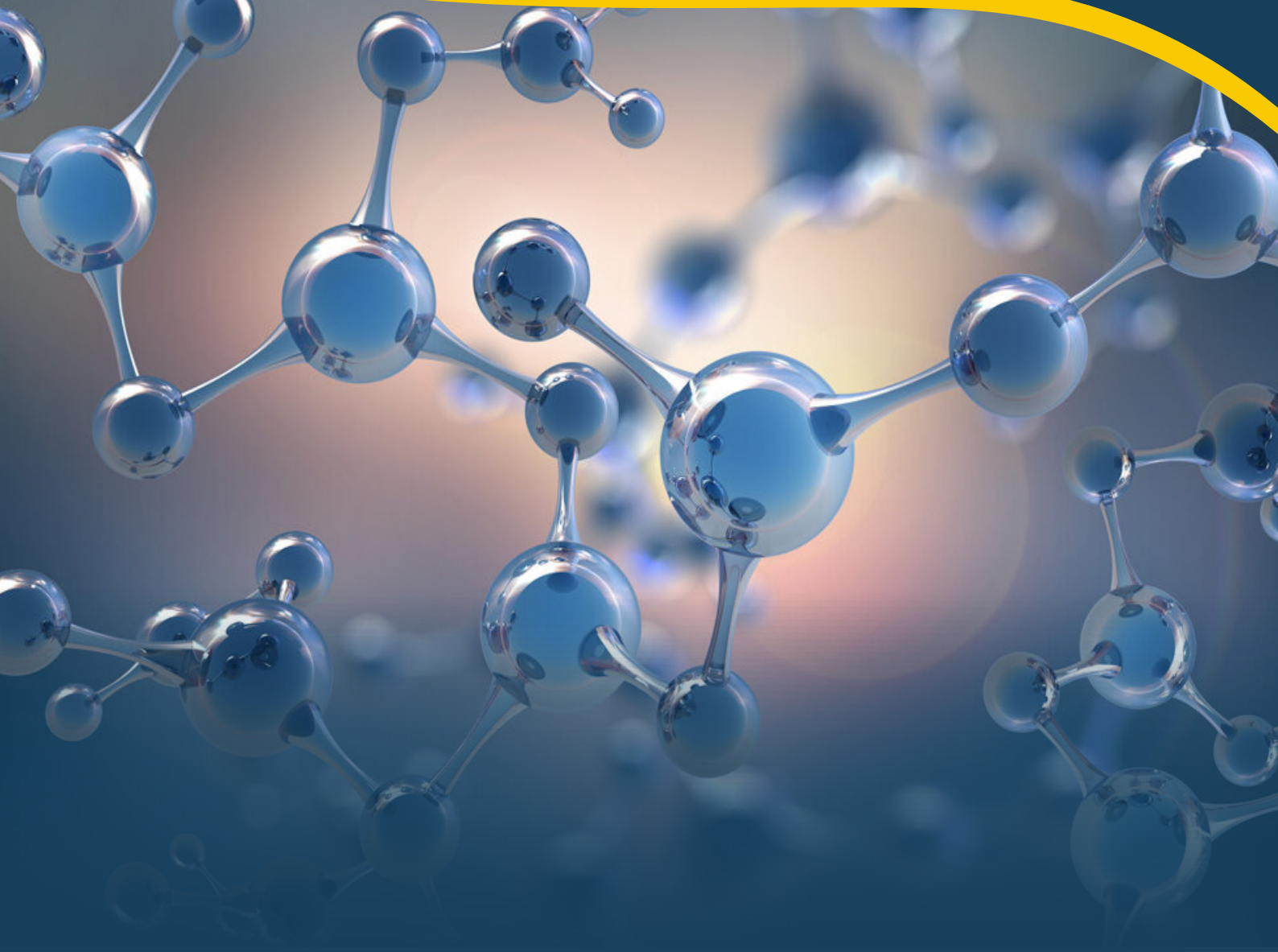
PAWAPULSE



Official Newsletter of Polymer Alumni Welfare Association, KPT, Mangaluru

SIXTH EDITION

Editorial Board

Office Bearers

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From the Desk of Chief Editor

My dear Reader,

On behalf of the entire editorial team, I am delighted to welcome you to our Polymer Technology newsletter "PAWApulse". As a leading source of information on the latest developments in polymer science and technology, we are committed to bringing you the most relevant and insightful content.

In this issue of March 2025, we feature Stars of PAWA, a write up by Pranesh about seminal work of western ghats, tyre and industry updates, activities conducted at department of polymer technology, technical papers about adhesion of elastomers with dissimilar substrate by krishnaprasad, comparison of sulphur and peroxide cure system in EPDM by Yatheendra Gowda, Bioplastics – the future of sustainable materials by Shubhakar. We hope you find the articles informative, engaging, and useful in your professional pursuits.

We value your feedback and encourage you to share your thoughts, suggestions, and ideas with us. Your input will help us shape the content and direction of our newsletter to better serve your needs.

Thank you for your continued support, and we look forward to keeping you informed and up-to-date on the latest advancements in polymer technology.

Best regards,

Er. Anil Pais

(D.Polm.Tech -Rubber Technology; PGDIRI; AMIE; MIE; CE-Mech Engg.; MSQM);SSBB -ISI; Lead Auditor – ISO9001:2015)

Chief Editor

From the desk of PAWA President

My dear PAWA'ites,

The formation of PAWA for the DPTians has proven to be a valuable and dynamic force in supporting both the college and its students. With a shared vision to promote the development of the rubber and plastic industries and empower future generations of engineers, the alumni are dedicated to fostering a vibrant relationship between the past and present of the program. Their contributions, both financial and intellectual, play a vital role in the continued success and growth of the college, while enhancing the career prospects and academic experiences of current students.

The core purpose of the PAWA is to create a platform where past graduates can reconnect, collaborate, and contribute to the betterment of their alma mater. It provides a space where alumni can share their experiences, expertise, and resources with the college community, thus helping students thrive in an ever-evolving industry. The association aims to:

- Foster Networking:
- Enhance Career Development
- Promote Knowledge Sharing
- Contribute to College Growth
- Contributions to the College

The PAWA plays a critical role in contributing to the continued advancement of KPT. Some of their key contributions include:

1. Financial Support:

- Scholarships and Awards:
- Infrastructure Development

2. Guest Lectures and Seminars:

- One of the most impactful ways alumni give back to the college is through guest lectures, seminars, and workshops. These sessions allow students to gain insights into the latest trends, challenges, and opportunities in the rubber and plastic industries. Alumni provide a wealth of knowledge from their hands-on experiences, helping students understand the practical applications of what they are learning.

  Alumni often introduce students to new areas of specialization within the industry, such as sustainable plastics, biodegradable materials, and smart rubber products, further broadening students' perspectives on the scope of the field.

Contributions to the Students

The PAWA's efforts extend beyond the walls of the college and have a profound influence on the career paths of current students. The following are some of the ways in which the PAWA contribute directly to the student community:

1. Internships and Job Placements:

- Through their extensive networks, PAWA connect students with potential employers in various sectors, including automotive, healthcare, and manufacturing, offering valuable internship and job placement opportunities. These experiences provide students with a direct pathway into the workforce, giving them the hands-on experience required to excel in the industry.

2. Mentorship

Many alumni serve as mentors, guiding students in their academic and professional journeys. They offer personalized advice on career choices, internships, and skill development, and act as sounding boards for student's ideas and spirations. Alumni mentors play an essential role in shaping student's career trajectories and helping them navigate the challenges of the rubber and plastic industries.

3. Industry Insights and Networking

Alumni are in a unique position to offer students a clear view of the ever-changing dynamics within the rubber and plastic industries. By sharing their professional experiences, alumni help students understand the specific skills required, the key players in the field, and the evolving industry needs

Alumni also provide networking opportunities through industry events, conferences, and professional groups. These connections are often instrumental in securing jobs and internships after graduation.

4. Real-World Experience

Many of the PAWA members who visiting to the college as guest speakers or mentors have extensive experience in diverse sectors of the rubber and plastic industries, including manufacturing, research and development, product design, and sustainability. Their input provides students with a deeper understanding of the industry's practical challenges, as well as opportunities for innovation and growth.

The PAWA is a crucial pillar of support for both the KPT and its DPTians through their contributions, PAWAaites not only enhance the academic experience for current students but also help prepare them for successful careers in a thriving, dynamic industry. Their financial support, expertise, mentorship, and connections ensure that students receive the guidance and opportunities they need to excel. This enduring partnership between PAWA and the KPT serves as a model for how professional networks and educational institutions can collaborate to create a more prosperous future for the rubber and plastic industries.

With this I wish all a Healthy year ahead & safe sailing

Best Regards,

Yatheendra Gowda
President
PAWA

A Panoramic View from the General Secretary

As I embark on this significant task of writing the panoramic glance for PAWApulse, I do so with a mix of nervousness and apprehension. This is my first attempt as General Secretary, and I'm aware that we've faced challenges in the past year.

Our last issue of PAWApulse was released in March 2024, and unfortunately, the proposed interim issue, PAWApulse NXT, didn't materialize. However, I believe that every setback is an opportunity for growth.

The past year has been eventful, albeit with some insipid periods. One significant highlight was the emergence of Shubhakar Nayak as our honorary PAWA Coordinator. Since taking over in November last year, he has revitalized our organization, established a reliable communication system, and completed the PAWA membership list with 491 members.

We're grateful for his efforts and look forward to his continued momentum. We're also thankful for the support of our Treasurer, Yashavantha Katte, and our President, Yatheendra Gowda.

Our AGM in August last year was a modest success, with the attendance of our Principal, Hareesha Shetty, and KPAA member Ivan Monterio. We also welcomed Divakar Moolya as our new Joint Secretary.

Although we didn't organize any notable events during the year, our parent Alumni association KPAA did, and many of our members actively participated. We commit to continuing this mutual cooperation.

We're fortunate to have a dedicated team, including our past Presidents, Vasudva Rao and Sriganesh U.P., who have provided steadfast support. Our Editor, Anil Pais, has been instrumental in bringing out six issues of PAWApulse, despite his busy schedule

As we look forward to the third edition of DPTCon, we're excited about the establishment of our Bengaluru Chapter, which will play a significant role in the upcoming event.

Thank you to all PAWAites for your support and enthusiasm
Here's to a charged and happening PAWApulse, coming soon!

- M. Gopalkrishna Bhat
General Secretary
PAWA

M. Gopalakrishna Bhat: A Shining Star in the PAWA Firmament

Meet our beloved, dynamic and energetic Shri M. Gopalakrishna Bhat, a 62-year-young gentleman who embodies the spirit of youthfulness, motivation, and social responsibility always. Affectionately known as GKB in our group, this dynamic individual has led a life marked by challenges and triumphs, always maintaining

Hailing from a humble background near Uppinangady, South Canara District (Dakshina Kannada) from Karnataka, GKB pursued his education at Govt. Junior College, Uppinangady, and later at Karnataka (Govt) Polytechnic, Mangalore, where he completed his Diploma in Polymer Technology (Rubber) passing in year 1981.

His professional journey began as a Rubber Technologist at Elastomer Processors, Mumbai, followed by stints at Modistone Tyres, Mumbai, United Rubber Industries, Bhayander, Vaid Elastomers, Rabale Navi Mumbai and Mega Rubber, Vasai.

In 2010, GKB returned to the tyre industry career joining M/S. Balakrishna Industries Ltd (BKT) Chopanki Plant, Rajasthan, where he is currently serving as Senior Manager -Technical.

Throughout his career, GKB has cultivated a congenial work culture, earning recognition and respect within his professional network

GKB's true strength lies in his exceptional social skills, conflict resolution abilities, and dedication to PAWA 24x7. As a key figure in establishing PAWA in 2016, he has played a pivotal role in maintaining the organization's unity and progress.

Having served as Joint Secretary for two terms and currently serving as General Secretary, GKB has always been one of the main pillars of PAWA.

His notable achievements include spearheading the successful conduct of two DPTCons, motivating the PAWA editorial team to publish e-editions of PAWAPulse and a physical souvenir, and launching the PAWA website 'www.kptpawa.in'.

GKB's socially vibrant nature has also led him to engage in various Kannadiga-related activities in Bhiwadi, Gurgaon, and Delhi, inspiring kids through Kannada classes and cultural events. GKB is happily married with a daughter who completed MBBS.

As GKB continues to shine bright in the PAWA firmament, we wish him many more years of satisfaction, success, and social impact.

Bymana Machaiya Suresh: A multifaceted Professional

As a seasoned professional with three decades of experience in the tyre and automotive component industry, Suresh had the privilege of working with esteemed organizations and contributing to various aspects of the business.

Early Life and Education

due to his Father's transfers. Suresh had completed his primary education in Sasthan and Karkada of Udupi taluk, High School and PU education in Kinnigoli, near Mangaluru. He then opted and pursued a diploma in Polymer Technology from Karnataka Polytechnic, Mangalore.

His professional journey began in 1994, as a supervisory trainee at Sri Chakra Tyres (now TVS Srichakra Tyres) in its mixing plant. He later moved to TVS's North Indian venture, leasing Proguard Tyres, Pithampur, M.P., where he had led the technical and QA teams. After returning to the mother plant, he worked in various capacities, including R&D and plant planning.

During this tenure, he pursued a BBA degree from Annamalai University.

In 2006, he joined Ace Tyres, Hyderabad, as Assistant Manager, overseeing mixing, extrusion, and calendering units and plant production planning.

It was in 2010 that he moved to Paracoat Products Ltd as Manager-Production, Quality Coordinator, interacting with Indian automotive OEMs for NVH and trims-related developments. He later assumed the role of AGM, taking on additional responsibilities in marketing and costing, becoming a techno commercial guy.

As a part of marketing, he got the opportunity to organise expo booths in Hannover, Germany and Seoul, South Korea. For a technology transfer, had a chance to visit a company in Jakarta, Indonesia. Being modest to the core, he humbly proclaims he has become a 'jack of all' but 'master of none'.

Suresh is married to Prathibhapreethi and have two children, Son Pranav who is pursuing BE in Robotics and Automation, and Daughter Chithkala is entering PU now. They are residing with his mother at Anekal, Bengaluru.

Apart from such an engaging career, Suresh had served as secretary of Karnataka Sangha, Madurai, for six years and actively participated in its activities for 12 years. In his free time, he enjoys creating short puns in Kannada on day-to-day happenings.

Polymerising with society is one of the interests, which keeps him going, growing and glowing.

Let us wish our shining Star PAWAite lot more successful and happening life all the way.

The Countdown to DPTCon-3 Begins!

The anticipation is building up, and the excitement is palpable! With DPTCon-3 just around the corner, slated to take place in the first quarter of 2026, the preparation and planning phase is in full swing.

As we approach the deadline for planning and conceptualizing, the complexity and challenges of organizing this grand event are becoming more apparent. While there are still some uncertainties surrounding the event, one thing is certain - this time, it's going to be bigger and better than ever!

Currently, we're working on finalizing the tentative aspects, including the venue, scope, and scale. Over the coming months, we'll be shaping the framework, and the excitement will only continue to grow.

For now, let's Savor the foundation-laying stage and conserve our energy for the upcoming event planning, organizing, and management phase. The countdown to DPTCon-3 has begun, and we can't wait to make it a memorable experience!

- Yashawanta Katte
Treasurer
PAWT

Mr. Pranesh is an alumnus of Karnataka Polytechnic, mangaluru, having passed diploma in Polymer Technology. Pranesh was selected as a Climate Champion of Young India by the National Youth Climate Consortium (NYCC), supported by Yu-Waah-UNICEF. This prestigious fellowship was awarded to Pranesh from a pool of over 1200 youth grassroots leaders across India, recognizing his potential to drive impactful change. As a youth representative of Karnataka.

Pranesh participated in a 3-day Capacity Building Training of Trainers, alongside 29 other Climate Champions, to enhance his skills in climate communications and advocacy, project management, and stakeholder engagement. Participated the Local Conference of Youth 2024 as an NYCC Youth Delegate, contributing to the formation of the National Youth Statement, which represents the recommendations of over 1500 young people and Designed and implemented a grassroots initiative called "Yuva - Panchayat for Western Ghats" and mentored and conducted a capacity-building workshop for 30 local youth leaders in the Western Ghats region.

1. Seminal Work in the Western Ghats: Ecology, Policy, and the Legacy of Madhav Gadgil

The Western Ghats, an ancient mountain range stretching along the western coast of the Indian peninsula across six states, represent a region of unparalleled ecological significance. This remarkable geological formation, older than the Himalayas, plays a critical role in shaping the Indian monsoon weather pattern, moderating the tropical climate and acting as a vital watershed for peninsular India. Recognizing its exceptional biodiversity and unique biophysical processes, the United Nations Educational, Scientific and Cultural Organization (UNESCO) declared the Western Ghats a World Heritage Site in 2012. This designation underscores the global importance of the region and highlights the profound value of any work that contributes to its understanding and conservation.
In December 2024, the global significance of the Western Ghats and the dedication of individuals working towards its preservation were once again brought to the forefront with the announcement that veteran Indian ecologist Madhav Gadgil was awarded the prestigious Champions of Earth award by the United Nations. This esteemed honour, the UN's highest environmental award, recognized Gadgil for his "seminal work in Western Ghats, a global biodiversity hotspot". Bestowed in the Lifetime Achievement category, the award acknowledges his decades-long commitment to conservation and environmental protection in this ecologically critical region. The term "seminal work" in this context refers to foundational contributions that have profoundly influenced the understanding of the Western Ghats' ecology, identified critical environmental challenges, and proposed significant strategies for its conservation and sustainable management. Madhav Gadgil's extensive body of work,

particularly his leadership of the Western Ghats Ecology Expert Panel (WGEEP), widely known as the Gadgil Commission, stands as a prime example of such impactful and foundational contributions.

2. Madhav Gadgil: The Ecologist and His Vision

Madhav Gadgil, born in 1942, possesses a distinguished academic background, culminating in a PhD in Mathematics from Harvard University in 1969. Upon returning to India, he embarked on a career dedicated to ecological research and education, serving as a professor at the Indian Institute of Science (IISc) in Bengaluru, Karnataka. His commitment to advancing ecological understanding in India is further evidenced by his founding of the Centre for Ecological Sciences at IISc, which has become a pivotal research institution in the field.

3. The Western Ghats: A Biodiversity Hotspot of Global Significance

The Western Ghats, an ancient mountain range predating the Himalayas, exert a profound influence on the Indian subcontinent's climate. Their high-altitude forest ecosystems play a crucial role in regulating the Indian monsoon, ensuring substantial rainfall on their western slopes while creating a drier rain shadow region to the east. This unique geographical feature serves as the origin for numerous rivers, forming a critical watershed that sustains the water needs of peninsular India for irrigation, hydroelectric power, and drinking water for a vast population.

Recognized globally for its exceptional biodiversity, the Western Ghats are classified as one of the world's eight "hottest hotspots". This designation highlights the region's extraordinary concentration of endemic species and the significant habitat loss it has experienced. Despite covering less than 6% of India's total land area, the Western Ghats harbor over 30% of all plant, fish, reptile, amphibian,

bird, and mammal species found in the country. The level of endemism is particularly high, meaning a substantial number of species found here exist nowhere else on Earth.

The flora of the Western Ghats is remarkably diverse, with approximately 7,402 species of flowering plants documented, of which 1,273 are exclusively found in this region. This includes a rich variety of trees, ferns, shrubs with medicinal properties, fungi, and over 40 species of wild orchids. Examples of unique and threatened plant life include the Ebony Tree (Diospyros ebenum), classified as endangered due to extensive logging; the vulnerable Mountain Daffodil (Dipcadi montanum), threatened by habitat loss; the vulnerable Western Ghats Palm (Rhopaloblaste augusta), impacted by habitat destruction and overharvesting; and the vulnerable Fantastic Ceropegia (Ceropegia fantastica), facing threats from habitat loss and collection. The region also boasts a stunning array of orchids, adding to its floral richness.

The Western Ghats are equally rich in faunal diversity, hosting a wide array of animal species. As of 2010, the region was home to 120 mammal species (14% endemic), 508 bird species (4% endemic), 121 amphibian species (78% endemic), 156 reptile species (62% endemic), and 218 fish species (53% endemic). The level of endemism is particularly high among amphibians. Notable examples of the region's unique fauna include the endangered Lion-tailed Macaque (Macaca silenus), an endemic primate with a distinctive silver-white mane; the endangered Nilgiri Tahr (Nilgiritragus hylocrius), an endemic mountain goat found in the higher altitudes; and the vulnerable Nilgiri Langur (Semnopithecus johnii), another endemic primate. Endemic bird species like the Malabar Grey Hornbill and the Malabar Whistling Thrush are also characteristic of the region. The amphibian diversity includes the unique Purple Frog, discovered relatively recently. Even within smaller taxa like

insects, high endemism is observed, for instance, in dragonflies like the vulnerable Saffron reedtail (Indosticta deccanensis). The rivers and streams are home to endemic and threatened fish species, such as the endangered Dwarf Malabar Puffer (Carinotetraodon travancoricus). Furthermore, the Western Ghats provide critical habitat for flagship mammal species such as the endangered Asian elephant (Elephas maximus), the tiger (Panthera tigris), and the gaur (Bos gaurus).

Despite its ecological richness, the Western Ghats face numerous threats that jeopardize its biodiversity. Habitat loss due to deforestation for agriculture, including the expansion of plantations like tea and coffee, urbanization, and infrastructure development such as roads and railways, remains a primary concern. Unsustainable agricultural practices, including monoculture farming and the heavy use of chemical pesticides and fertilizers, contribute to soil erosion, habitat degradation, and water pollution. The impacts of climate change, such as altered rainfall patterns and increased frequency of extreme weather events like floods and landslides, further exacerbate the vulnerability of the ecosystem. Mining, quarrying, and large-scale construction projects cause significant and often irreversible damage to the landscape, leading to habitat destruction, soil erosion, and increased risk of landslides. The introduction of invasive alien species disrupts native ecosystems, while pollution from industrial and agricultural sources contaminates water and soil. Finally, the overexploitation of natural resources, including illegal logging, overharvesting of forest products, and wildlife poaching, continues to threaten the region's unique biodiversity.

4. The Seminal Work: The Gadgil Commission Report

Recognizing the escalating threats to the ecological integrity of the Western Ghats, the Union Ministry of Environment and Forests (MoEF) established the Western Ghats Ecology Expert Panel (WGEEP) in 2010. The panel was tasked with conducting a comprehensive examination of the ecological issues affecting the region and recommending measures for its conservation and sustainable development, aiming to f ind a balance between environmental protection and the needs of local communities. The MoEF appointed the esteemed ecologist Madhav Gadgil, whose extensive research and deep understanding of the Western Ghats ecosystem were widely acknowledged, as the chairman of this crucial panel. The panel, under Gadgil's leadership, submitted its comprehensive report to the Government of India on August 31, 2011.

A central recommendation of the Gadgil Commission report was to designate the entire Western Ghats as an Ecologically Sensitive Area (ESA), encompassing approximately 64% of the region. This broad designation stemmed from the understanding that the Western Ghats constitute a contiguous and ecologically interconnected region, necessitating a holistic approach to conservation rather than fragmented efforts. Within this ESA, the report proposed a classification of 142 taluks bordering the Western Ghats into three Ecologically Sensitive Zones (ESZ 1, 2, and 3) based on their varying levels of ecological sensitivity. ESZ 1 was identified as the zone requiring the highest level of protection. This zoning approach aimed to implement differentiated levels of regulation, with stricter controls in the most ecologically fragile areas and relatively more flexibility in less sensitive zones.

In the zones identified as most ecologically sensitive (ESZ 1 and 2), the report recommended stringent regulations or a complete ban on activities known to have

a high environmental impact. These included an indefinite moratorium on new environmental clearances for mining in ESZ 1 and 2, with a complete phase-out of mining from ESZ 1 within five years. The commission also proposed prohibiting the establishment of new "red" and "orange" category industries, such as coal-based power plants, in these zones, and called for strict regulations on large-scale construction activities. To address the issue of pollution, the report recommended a phase-out of all chemical pesticides within five to eight years in ESZ 1 and ESZ 2, and a phasing out of plastic bags within three years in these zones. Reflecting concerns about the potential ecological risks, the commission also advocated for a complete ban on the cultivation of Genetically Modified (GM) crops throughout the entire Western Ghats region. To limit the impact of large-scale development, the report proposed a prohibition on the development of new special economic zones (SEZs), hill stations, large storage dams, railway lines, and major roads within ESZ 1 and 2. Recognizing the importance of preserving natural land cover, the commission recommended a ban on the conversion of public lands to private ownership and on the diversion of forest land for non-forest purposes within ESZ 1 and ESZ 2. Furthermore, the Gadgil Commission emphasized the need to regulate tourism in the Western Ghats region to minimize its potential negative impacts on the environment and local communities.

A fundamental principle underlying the Gadgil Commission's recommendations was the emphasis on a participatory approach to conservation, strongly advocating for the involvement of local communities in decision-making processes related to the management and protection of the Western Ghats. The report proposed a shift from a top-down, centralized system of environmental governance to a bottom-up approach that empowers local authorities, particularly Gram Sabhas (village councils), in environmental decision-making.

This reflected Gadgil's belief that conservation efforts are more likely to be successful and sustainable when they involve and empower the people who live in and around the protected areas, recognizing their valuable traditional ecological knowledge and direct stake in the health of their environment. To facilitate the implementation and oversight of these conservation measures, the commission recommended the constitution of a Western Ghats Ecology Authority (WGEA) as a statutory body under the Ministry of Environment and Forests. This authority was envisioned to possess the necessary legal and administrative powers to effectively manage the region's ecology and ensure sustainable development.

5. The Aftermath: Controversies, Counter-Proposals, and Implementation Challenges

the Gadgil Commission report, with its comprehensive and often stringent recommendations, encountered significant resistance from various stakeholders. The governments of the six states through which the Western Ghats pass, local communities who feared restrictions on their livelihoods, and industries involved in mining, quarrying, and other developmental activities all voiced strong opposition. A primary concern revolved around the potential economic impacts of the proposed regulations, with fears of job losses and economic hardship, particularly in sectors like mining and agriculture. Critics also argued that the recommendations were impractical, not adequately considering the ground realities and developmental needs of the region and its inhabitants. Some experts felt that treating the entire Ghat region as a homogeneous entity overlooked important micro-level differences. The recommendation to establish a new statutory body like the WGEA also faced opposition, with some arguing that existing laws and agencies were sufficient. Furthermore, differing opinions existed on the ecological impact of certain activities, such as cardamom cultivation. Misinformation spread

by some local politicians also contributed to the opposition from certain communities who perceived the report as detrimental to their well-being.

In response to the widespread opposition, the Union government formed a High-Level Working Group (HLWG) in August 2012, chaired by space scientist K. Kasturirangan, to review the Gadgil report and propose more widely acceptable measures for the ecological protection and sustainable development of the Western Ghats. The Kasturirangan report, submitted in 2013, recommended a significantly smaller ecologically sensitive area, covering only 37% of the Western Ghats (59,940 square kilometers), aiming to address concerns that the Gadgil report's broader coverage would impede economic growth. The panel categorized the Western Ghats into 'cultural regions' (human settlements, agriculture, plantations, covering around 60% of the area) and 'natural regions' (the remaining area), proposing to designate the 'natural regions' as the Ecologically Sensitive Area (ESA). The report also introduced an activity-based classification, categorizing activities into 'red' (banned in ESA, e.g., mining), 'orange' (regulated and permitted with permissions), and 'green' (generally allowed, e.g., agriculture).

Despite the submission of both reports, the final notification declaring the Western Ghats as ecologically sensitive has faced significant delays due to continued objections from the involved states. While five draft notifications were issued by March 2014, a final consensus and implementation remain elusive. Consequently, ecologist Madhav Gadgil has expressed his disappointment that his report's recommendations were largely ignored, and he believes that environmentally damaging activities like mining and construction continue unabated in the Western Ghats. He has even stated that the region may have crossed a "tipping point," evidenced by the increasing frequency of landslides, and suggests that the implementation of his report's recommendations could have significantly mitigated

these impacts. Gadgil has also highlighted instances where local communities are already suffering the consequences of environmental degradation, with their agriculture and fisheries negatively affected by activities like quarrying and mining.

6. Enduring Legacy and the Path

Forward Despite the challenges in its full implementation, the Gadgil Commission report has left an undeniable and enduring legacy on conservation policy in India. It played a pivotal role in bringing the ecological fragility of the Western Ghats to the forefront of national environmental discourse and policymaking, prompting a critical examination of the balance between development and environmental protection in the region. Gadgil's strong emphasis on a participatory, community-driven approach to conservation has also had a lasting influence on conservation thinking, advocating for the empowerment of local communities and the recognition of their traditional ecological knowledge. The contrasting recommendations and the ensuing debate between the Gadgil and Kasturirangan reports have clearly highlighted the persistent tension between the need for robust environmental protection and the pressures of economic development in India. Recent environmental disasters, such as the flash floods and landslides in Kerala, have tragically underscored the potential consequences of unsustainable development in ecologically sensitive areas like the Western Ghats, bringing the recommendations of both reports back into sharp focus and emphasizing the urgent need for a more sustainable and ecologically conscious approach to development.

Looking towards the future, a renewed focus on implementing the more comprehensive and ecologically sensitive recommendations of the Gadgil report may be necessary, particularly in light of increasing environmental degradation in the Western Ghats. This could involve revisiting the proposed zoning and stricter regulations in the most fragile areas. Strengthening community participation and empowering local communities in the management and conservation of the

Western Ghats remains crucial for long-term success, aligning with Gadgil's core vision. Future development in the region must adopt a more holistic and integrated approach that fully considers the long-term ecological consequences of all activities, prioritizing environmental sustainability alongside economic considerations. Significant investment is needed in ecological restoration and afforestation efforts using native tree and plant species to help restore degraded habitats and enhance biodiversity. Effective conservation also requires robust monitoring and strict enforcement of environmental regulations throughout the Western Ghats. Finally, raising public awareness and educating local communities about the unique ecological significance of the Western Ghats and the importance of conservation are essential for fostering a sense of environmental stewardship and ensuring the long-term protection of this invaluable natural heritage.

7. Conclusion: Reflecting on Seminal Work and the Imperative for Sustainable Conservation

Madhav Gadgil's work stands as seminal in bringing critical attention to the ecological challenges confronting the Western Ghats. His comprehensive assessment and far-reaching recommendations, though facing considerable opposition, have indelibly shaped the discourse on environmental protection in this globally significant biodiversity hotspot. Gadgil's enduring vision of community-based conservation and sustainable development remains profoundly relevant in the face of increasing environmental degradation. The urgent need for effective implementation of robust conservation measures to safeguard the Western Ghats for future generations cannot be overstated. It requires a concerted effort from policymakers, local communities, and all stakeholders to work collaboratively towards a sustainable future for this irreplaceable natural treasure.

Compiled by Mr. Pranesh

Job Opportunities

Understanding Different Roles

Job Holder – An individual employed to complete specific tasks within a given timeframe, regardless of circumstances.

Job Seeker – A person actively searching for job opportunities.

Job Consultant – A professional who assists job seekers in finding suitable employment, usually as a paid service.

Job Supporters (Us) – Those who may not be actively seeking jobs but are committed to helping others secure employment. As PAWAites, we should contribute by guiding and supporting job seekers in meaningful ways.

Key Factors to Consider Before Joining a Company

Before accepting a job offer, it is essential to evaluate the company and the opportunity it presents. Consider the following:

1. **Company Size** – How many employees does the organization have?
2. **Existing Connections** – Do you know anyone working there, especially fellow PAWAites?
3. **Referrals** – Do you know someone suitable for the job?
4. **Application Process** – What steps must a candidate take to secure the job?
5. **Eligibility Criteria** – What are the minimum qualifications required for selection?
6. **Skill Development** – What fields or specializations does the company offer for expertise?
7. **Career Growth** – What kind of career advancement can be expected?
8. **Entrepreneurial Potential** – Does this job provide the skills and experience neces sary to become an entrepreneur in the future?

By considering these aspects, we can help job seekers make informed decisions and support them in building successful careers. As PAWAites, let's take the initiative to assist others in finding the right job opportunities!

By Rajpal Singh

Tyre and Automotive updates

The Indian tyre industry has seen significant developments recently, reflecting both growth prospects and challenges

Industry Growth and Investments

The industry is projected to expand rapidly, with market size expected to reach US $29.16 billion by 2030, growing at a CAGR of 8.21% from US $12.84 billion in 2024. In the past three years, tyre manufacturers have invested approximately Rs 35,000 crore in capacity expansion and operational improvements. Looking ahead, the Automotive Tyre Manufacturers' Association (ATMA) anticipates that the industry's turnover will surpass Rs 1 lakh crore within the next three years.

a. Export Performance

Tyre exports from India have been robust, growing 17% year-on-year to reach Rs 6,219 crore in the first quarter of the current fiscal year. The United States remains the largest market for Indian tyres

b. Corporate Developments

a) Leadership Changes: Anuj Kathuria, President of JK Tyre & Industries, resigned amid a police investigation involving serious charges. Kathuria has denied the accusations, labeling the FIR as false and defamatory.

b) Strategic Acquisitions: CEAT Limited has agreed to acquire Michelin's Camso brand for $225 million. This acquisition aims to enhance CEAT's presence in the off-highway tyre segment, covering vehicles like tractors and bulldozers.

c) Sustainability Initiatives: JK Tyre & Industries secured a $100 million Sustainability-Linked Loan from the International Finance Corporation (IFC). The funds are allocated for expanding production in Madhya Pradesh and Uttarakhand, promoting energy-efficient tyre manufacturing, and generating employment

c. Industry Challenges

Despite positive export figures, the tyre industry faces challenges, including rising raw material costs and subdued demand in certain segments. CRISIL forecasts a 7-8% revenue growth for the industry in FY25, marking a slowdown compared to the 21% CAGR between FY21 and FY23. Overall, while the Indian tyre industry is poised for growth, it must navigate challenges related to costs and demand fluctuations to maintain its trajectory.

i. Maruti Suzuki to Increase Car Prices

Maruti Suzuki India, the country's leading car manufacturer, has announced a price increase of up to 4% across its car models, effective from April 2025. This decision is attributed to rising costs of raw materials and operations. The hike will vary depending on the specific car model. This follows a similar 4% increase implemented in January and additional price adjustments in February. Indian automakers are currently facing challenges due to global commodity price surges, steep import duties on raw materials, and supply chain disruptions.

ii. SUV Sales Drive Market Amid Economic Slowdown

Despite a general economic slowdown, Indian carmakers like Mahindra and Tata Motors are experiencing robust sales in the high-end SUV segment. In 2024, SUV sales in India increased by 14%, now comprising 56% of the market, reflecting a growing preference among affluent customers. While the overall passenger vehicle market grew by a modest 5%, luxury SUV brands performed notably well. Industry leaders observe a trend where premium products are growing faster than lower-priced ones.

d. US-India Trade Discussions on Auto Tariffs

The United States is advocating for India to eliminate tariffs on car imports as part of a proposed bilateral trade deal, which would facilitate Tesla's entry into the Indian market. India currently imposes auto tariffs of up to 110%, among the highest globally. While formal trade talks have not commenced, the U.S. has expressed expectations for tariff reductions. India is considering further cuts but is cautious about reducing tariffs to zero immediately. Domestic automakers have expressed concerns that lowering tariffs could impact local manufacturing and investments.

e. Harley-Davidson and Hero MotoCorp Expand Collaboration

Harley-Davidson is expanding its collaboration with Hero MotoCorp to introduce a new motorcycle and expand the X440 range. The initial collaboration, which launched the successful Harley-Davidson X440 from Hero MotoCorp's Rajasthan factory, is set to bring more variants, possibly including a scrambler model. This partnership aims to offer diverse price options and features, maintaining Harley-Davidson's signature style and performance.

f. JSW to Launch Its Own EV Brand

Indian steelmaker JSW has announced plans to launch its own electric vehicle (EV) brand, marking its entry into India's growing EV market. The company has established a new car plant in Aurangabad, Maharashtra, dedicated to producing vehicles under its own brand. This move positions JSW among other players in the Indian EV market, including Tata Motors, Mahindra, and Ola Electric

g. Bharat NCAP: Enhancing Vehicle Safety Standards

The Bharat New Car Assessment Program (Bharat NCAP) was officially launched in August 2023 as India's official vehicle safety assessment program. It assigns star ratings to cars sold in the country based on their safety performance. Within two years of implementation, new cars sold in India are expected to comply with

voluntary star ratings based on crash safety performance tests. This initiative aims to harmonize India's vehicle safety standards with global standards, potentially aiding automakers in exporting locally produced cars globally.

h. Auto Expo 2025 Highlights

The 17th edition of Auto Expo, held from January 17 to 22, 2025, at Bharat Mandapam in New Delhi, showcased a range of production-spec cars from various manufacturers. Notable models included Tata Motors' Punch CNG, Punch.ev, and Harrier.ev; Kia's Carens and Carens X-Line; Maruti Suzuki's Dzire and e Vitara; and Toyota's Land Cruiser J300 and Innova Hycross. The event highlighted the industry's focus on electric and alternative fuel vehicles, reflecting a shift towards sustainable mobility solutions.

Compiled By Mr. Sriganesh U.P.

RUBBER & PLASTICS EVENT CALENDER 2025

Jan 17- 22	Bharat Mobility Global Expo 2025 | Pragati Maidan, New Delhi, India
Jan 23-29	Imtex 2025/Tool Tech 2025 | BIEC, Bengaluru, India
FEB 19-22	Off-the-road Tire Conference 2025 | LAS Vegas, NV, USA
FEB 20	ET Auto Connected Vehicle Summit | Chennai, India
Mar 4-6	Tire Technology Expo 2025 | Hannover, Germany
Mar 12-14	Tyre Expo Asia 2025 | Marina Bay Sands, Singapore
Apr 1-2	Plastics Recycling Show, Europe | Rai, Amsterdam, Netherlands
Apr 2-5	PLAST SHOW 2025 | Rajkot, Gujarat, India
Apr 8-10	Automotive Testing Expo 2025 | CTC, Chennai, India
Apr 9-11	Polyurethane Exhibition & Conference - India (PUTECH) | Greater Noida, India
Apr 10-11	12th Vinyl India : International PVC & Chlor – Alkali Summit | Jio World Convention Centre, Mumbai, India
Apr 15-18	Chinaplas 2025 | Shenzhen World Exhibition Centre (Boo'an), PR China

Apr 22-24	Clemson University Global Tire Industry Conference 2025 | Downtown Greenville, South Carolina, USA
May 7-9	Future Mobility Asia 2025 | Bangkok, Thailand
May 9-10	PLASTASIA | BIEC, Bengaluru, India
May 9-10	Synthetic Rubber Conference | RG Royal Hotel, Yeshwantpura, Bangalore, India
May 8-10	Automechanika KL 2025 | KLCC, Malaysia
May 8-10	Plastics Recycling World Expo India 2025 | BEC, Mumbai, India
May 14-15	Plastics Recycling Show, Europe | Rai, Amsterdam, Netherlands
May 14-17	Plastics & Rubber Thailand | BITEC Bangna, Bangkok, Thailand
May 20-22	Automotive Testing Expo 2025 | Messe Stuttgart, Germany
May 21-23	INAPA 2025 | Jakarta, Indonesia
May 21-24	Autopromotec | Bologna, Italy
May 27-30	Greenplast | Milan, Italy
Jun 10-11	Plastics Recycling Technology | Long Beach, CA, USA
Jun 11-12	Future Mobility Conference 2025 | India

Jun 17-20	2nd Global Conclave on Plastic Recycling & Sustainability | Bharat Mandapam, (Pragati Maidan), New Delhi, India
Jun 24	Tyre Materials Conference 2025 | Le Meridien, New Delhi, India
Jun 25-27	Rubber & Tyre Vietnam 2025 | SECC, Vietnam
Jul 8-10	IFAT Africa | Johannesburg, South Africa
Jul 9-11	Latin Tyre Expo & Latin Auto Parts Expo 2025 | Panama
Jul 11-13	4th Plastics, Packaging, Printing Expo (P3-Expo) | CK Convention Centre, Guntur, AP, India
Aug 1-3	Total Plastics Expo 2025 | Codissia Trade Fair Complex, Coimbatore, India
Sep 8-11	International Elastomer Conference 2025 | Cleveland OH, USA
Sep 9-14	IAA Mobility 2025 | Munich, Germany
Sep 11-14	KPLEX 2025 | Adlux International Convention Centre, Kochi, India
Sep 15-17	Plastics Recycling Show-Middle East & Africa | World Trade Centre, Dubai
Sep 17-19	Rubber Tech China 2025 | Shanghai, PR China
Oct 8-15	K 2025 | Dusseldorf, Germany
Oct 10-12	International Plastics Expo 2025 | BEC, Mumbai, India

Oct 29-31	3rd World Recycling Convention | Barcelona, Spain
Nov 4-7	Appex/Sema Show | Las Vegas NV, USA
Nov 7-9	Packplus South | HITEX Exhibition Centre, Hyderabad, India
Nov 13-15	Plastics Recycling Show India 2025 | BEC, Mumbai, India
Nov 26-29	Odisha Plast International Expo 2025 | Janata Maidan, Bhubaneswar, India
Dec 5-7	North East Plast Expo 2025 | Ekana Sports City, Lucknow, India
Dec 9-13	EXCON | BIEC, Bengaluru, India
Feb 5-10 2026	PLASTINDIA - International Plastics Exhibition, Conference & Convention | Bharat Mandapam, New Delhi, India
Apr 7-10 2026	India Rubber Expo 2026 | ITPO Delhi, India

- Compiled by Rajesh Rao,
BERATEX, Bangalore. +91 9886938802

Activities Carried out for improvement of Diploma In Polymer Technology Campus -Karnataka Polytechnic, Mangaluru with the help from Polymer Alumni Welfare Association (PAWA)

Technical Seminar By PAWA Team, Online and Offline

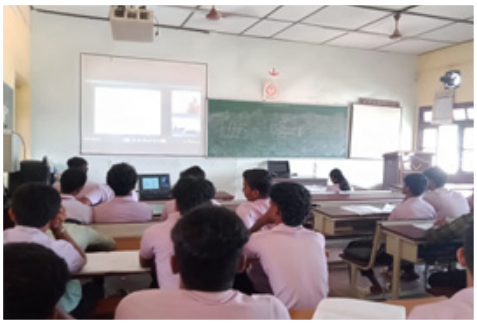
The technical seminar, both online and offline, organized for the advancement of Polymer Technology students through the support of alumni (PAWA), stands as a testament to the collaborative spirit and dedication towards nurturing the next generation of professionals.

In the ever-evolving landscape of polymer technology, staying abreast of the latest advancements and industry trends is paramount. Recognizing this need, the alumni association (PAWA) generously extended their expertise and resources to orchestrate a series of technical seminars, both online and offline, tailored specifically for the benefit of current Polymer Technology students. The online component of the seminar provided a virtual platform, transcending geographical barriers and enabling students to access invaluable insights from industry experts and seasoned alumni professionals from across the globe. Through engaging webinars, interactive sessions, and panel discussions, students had the opportunity to delve deep into various facets of polymer technology, ranging from material science to manufacturing processes, and gain practical insights into real-world applications. Complementing the online sessions, the offline segment of the seminar offered an immersive learning experience within the college premises. Facilitated by esteemed alumni speakers and industry leaders, these in-person sessions provided students with hands-on workshops, live demonstrations, and networking opportunities, fostering a conducive environment for knowledge exchange and skill enhancement.

Virtual class on Rubber Testing and its inportence by Ajay C HASETRI Mysore on 04-03-2025

Virtual class on Basics of Polymer Science and Rubber Technology on 18-02-2025 by Dr. R. Mukhopadhya director, R&D JK Tyre and industries Mysore.

Virtual class on Rubber moulded products and its applications by Vasudeva Rao S founder president PAWA/PAWT, Ex Journal secretary IRI on 21-02-2025



Virtual class on Latex products and Application and testing by Anil P Senior Technical Manager Kurlon Bangalore on 08-03-2025

Other Activities conducted at department of Polymer Technology

With our Honourable Director -Department of Collegiate and Technical Education, JD-Shekhar, and our respected State NSS Coordinator - Dr Guruprasad M Hugar.😊

Best NSS Cadet Miss. Vaishnavi of 2nd Year Polymer selected as best NSS cadet and participated in Republic Day Pared-2025 at Bangalore.

Best NSS Cadet Miss. Vaishnavi of 2nd Year Polymer participated in state level Republic Day camp 2025 at Bangalore

Activities carried out

Traditional Day Celebration by Polymer students with Local/ Traditional dress

Santhosh Kumar P HOD of Polymer dept. Won best NSS officer for the year 2025 with his team.

Shubhakar Nayak G guiding his team about the development of Agro products/Composites

Ayudha Pooja
celebration at PPT lab

Academics and Placements done for DPT Students


KARNATAKA (Govt.) POLYTECHNIC MANGALORE
DEPARTMENT OF POLYMER TECHNOLOGY
PLACEMENT 2023-24
GOWTHAM I
Trelleborg Sealing Solutions India Pvt Ltd
PRASHANTHA S V
HIGHER STUDIES
SANGEETA RAMA GOND
MANJUSHREE TECHNOPACK PVT LTD


KARNATAKA (Govt.) POLYTECHNIC MANGALORE
DEPARTMENT OF POLYMER TECHNOLOGY
PLACEMENT 2023-24
ABHISHEK MIRANDA
HIGHER STUDIES
AJAY L K
HIGHER STUDIES
AMAN J SHETTY
Trelleborg Sealing Solutions India Pvt Ltd
ANANTH KUMAR
HIGHER STUDIES
ANUSH RAI
HIGHER STUDIES
ASHWITH
MANJUSHREE TECHNOPACK PVT LTD
DAWAL
Toyoda Gosei South India Pvt Ltd
DHANUSH SALIAN
VELDEL PVT LTD

CURRENT STATUS OF POLYMER INDUSTRIES

The global polymer industry is a vital component of the chemical sector, encompassing a broad range of materials with diverse applications, from everyday consumer goods to advanced industrial products. Polymers, both synthetic and natural, are used extensively in packaging, construction, automotive, healthcare, electronics, textiles, and more.

Current State of the Polymer Industry

1. Market Growth and Demand

The polymer industry continues to experience robust growth driven by increasing demand across various end-user industries. Key regions like North America, Europe, and Asia-Pacific are showing rising consumption due to rapid urbanization, industrialization, and growing middle-class populations, particularly in emerging economies like China and India. The demand for lightweight, durable materials is also pushing the growth of the polymer sector in automotive and packaging applications.

2. Types of Polymers

- Thermoplastics such as polyethylene (PE), polypropylene (PP), and polyvinyl chloride (PVC) dominate the market due to their versatility and ease of processing.
- Engineering Plastics like polycarbonate (PC), nylon (PA), and polystyrene (PS) are in high demand for automotive, aerospace, and electronics applications, driven by the trend toward high-performance materials.
- Biodegradable Polymers are seeing increased interest as the world grapples with environmental concerns, leading to a rise in demand for eco-friendly alternatives in packaging, agriculture, and medical sectors.

CURRENT STATUS OF POLYMER INDUSTRIES

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3. Innovation and Technological Advances

The polymer industry is heavily investing in research and development to improve material properties, reduce costs, and discover new applications. Significant advances in polymer processing technologies (such as 3D printing, extrusion, injection molding, and blow molding) have resulted in enhanced performance and product customization. Innovations in smart polymers that respond to environmental stimuli and polymers with enhanced mechanical properties have made their way into specialized fields like healthcare and electronics.

4. Sustainability Challenges and Opportunities

One of the most pressing challenges the polymer industry faces is sustainability. The massive accumulation of plastic waste is a growing environmental concern, leading to calls for more responsible production and consumption. The industry is under increasing pressure to develop sustainable solutions, such as:

Recycling: New technologies for plastic recycling, including mechanical and chemical recycling processes, are advancing.

Bioplastics: Polymers derived from renewable resources (such asplant-based materials) are being developed to replace traditional petroleum-based plastics.

Circular Economy: Efforts to develop a circular economy in the polymer industry, focusing on reducing waste, reusing materials, and recycling products at the end of their life cycle, are gaining momentum.

5. Environmental Regulations and Policies

Governments worldwide are implementing stricter regulations on plastic usage, especially single-use plastics, to combat plastic pollution. This has created a demand for alternative materials and processes. Companies are investing in eco-friendly polymer production methods to meet environmental standards, which are expected to continue tightening in the coming years.

6. Impact of COVID-19

The COVID-19 pandemic disrupted the polymer industry, particularly the supply chain, as many factories halted production and transportation networks were disrupted. However, the demand for certain polymer products, such as medical-grade plastics, personal protective equipment (PPE), and disinfectant packaging, surged during the pandemic. The recovery phase has seen a rebound in polymer demand, although supply chain issues persist.

7. Global Supply Chain and Raw Material Prices

The industry is currently dealing with price volatility in key raw materials, including oil and natural gas, as polymers are derived from petrochemicals. Geopolitical instability, such as trade tensions and the war in Ukraine, has further exacerbated the supply chain challenges and led to rising costs in polymer production.

8. Future Trends

Digitalization: The adoption of AI and data analytics to optimize polymer production processes and improve supply chain management is growing.

Advanced Materials: Polymers with enhanced properties for specific applications (e.g., anti-microbial properties for medical polymers, UV resistance for outdoor materials) will see increased demand.

Alternative Feedstocks: Research into the use of renewable feedstocks like algae and CO2 in polymer production is an area of ongoing interest, aiming to reduce dependency on fossil fuels.

Conclusion

The polymer industry is undergoing rapid transformation, driven by technological advancements, evolving consumer needs, environmental challenges, and regulatory pressures. Companies are responding to these dynamics with innovation, especially in sustainable production methods, high-performance materials, and smart polymers. While challenges such as sustainability and raw material costs persist, the future of the polymer industry holds promising opportunities for growth, particularly with the increasing focus on circularity and eco-friendly solutions.

By
Yatheendra Gowda
Plant Head
M/s Avigiri Urethane and Rubber
Industries Pvt Ltd – Tumkur

Scope of plastics in India

The scope of plastics in India is broad and multi-dimensional with ample opportunities and challenges. Some of the key points include

Opportunities

1. Economic Growth: The plastics industry is one of the key sectors contributing to the Indian economy by providing employment to millions and supporting various sectors like packaging, automotive, healthcare, and construction.

2. Innovation: There is a growing interest in the development of sustainable and eco-friendly plastic products, such as bioplastics and recyclable materials.

3. Circular Economy: This includes initiatives like the "Roadmap for India's Circular Economy for Plastics" through which landfills for waste are lessened and recycling percentages are more enhanced by promoting secondary markets for old plastics.

4. International Commitments: There is international argument on plastic pollution and India is also doing its duty in terms of alignment with the policies of sustainability globally.

Barriers

1. Plastic Waste Management: Plastic waste management still remains a huge issue. The problems of blocked drains, flooding, and contamination of rivers and the marine environment continue.

2. Policy: There are ambitious policies but uneven implementation and enforcement.

3. Public Awareness: Creating an increased awareness of public's and changing consumer behavior for decreased plastic usage and recycling would contribute to long-term sustainability.

Future Outlook

1. Technological Advancements: Research and development in plastic recycling technologies and bioplastics may be enhanced for better alternatives.

2. Government Initiatives: "Swachh Bharat Abhiyan" (Clean India Mission) and "Atmanirbhar Bharat" (Self-Reliant India) are encouraging waste management and sustainable practices.

3. International Collaboration: India's active participation in global treaties and agreements on plastic pollution can influence international standards and practices. India's journey towards a more sustainable plastics industry is ongoing, with both significant opportunities and challenges ahead. What are your thoughts on the future of plastics in India?

Uses of plastics in modern era:

In the modern era, plastics play a crucial role in various aspects of daily life and industries. Here are some of the key uses of plastics

1. Packaging

Food packaging – plastics keep the food and other food items fresh.

Plastics for beverages, pesticides household chemicals cosmetics and pharmaceutical containers

2. Medical industry

- Medical devices-the syringe IV bags instruments and prosthetic limbs;

  Pharmaceutical packaging-plastic bottles or blister for containing medicines.

3. Cars

Components for the making car light but sturdy plastic auto parts help the car achieve fuel economy and save from weight

- **Inner Trim:** Dashboard, cushion seats, inner panelling.

4. Electronics

- **Housing:** For mobile handsets, computers, televisions, and others.
- **Insulation:** electrical insulation as well as insulation to cover the wire and cables.

5. Building

- **Tubing and Valves:** PVC tubing is more used in plumbing and conduits of electricity.
- **Insulation Products:** foam products that can be insulated to buildings.

6. Consumer Goods

- **Household:** plastic wares, home furniture, toys, box etc
- **Textile:** synthetic type polyester, nylon, use in clothes, upholstery.

7. Agriculture

- Plastic films and sheets for greenhouses.
- Plastic pipes and drip irrigation parts for irrigation systems.

8. Renewable Energy

- Protective coatings and backing materials for photovoltaic cells of solar panels.
- Lightweight, tough blades of composite plastics for wind turbines.

Sports and Recreation

- Sports gear, protective gear, and accessories made of plastic.
- Durable, weather-resistant plastic furniture for outdoor use.

Plastics are valued for their versatility, durability, and cost-effectiveness, making them indispensable in modern society. However, their environmental impact requires ongoing efforts to improve recycling and develop sustainable alternatives.

By:
Shubhakar Nayak Gowrimoole
Coordinator, PAWA/PAWT

Technical Articles

"ADHESION OF ELASTOMERS WITH DISSIMILAR SUBSTRATE" - AN AMAZING CHEMISTRY

Adhesion is really a wonder of the material science and it plays its role between two or more dissimilar surfaces. In Elastomers it is an amazing chemistry which holds it with metal, fabric and inorganic filler surfaces through a combination of chemical and / or physical interactions. Here the interactions between Elastomer with metal / fabric is termed as "Bonding" and same between Elastomer and inorganic filler is termed as "Coupling"! Now let us sink into this wonderful pool of this phenomena!!

"Adhesion" is a state in which one surface of material holds the surface of another similar or dissimilar material through an interfacial force. It is different from the term "cohesion" which is nothing but a strength of material in holding itself. The fundamental forces behind this phenomena are as below.

Inter atomic or primary bonding forces are:

- Ionic bond by transfer of electrons
- Covalent bond by sharing the electrons
- Metallic bond in which metallic ions surrounded by a pool of electrons.

Inter molecular or secondary bonding forces are:

- Stronger dipole attractions or hydrogen bond influenced by the forces of attraction between hydrogen and highly electronegative poles having Oxygen, Nitrogen, Halogen.....etc.
- Weaker dipole attractions between polar molecules other than hydrogen containing molecule.
- Induced polar attractions in which one polar molecule induces opposite polarity in its neighbor non-polar molecule and establishes a weak force of attraction.

These above fundamental forces influences the adhesion through following factors.

1. Molecular weight and branching: Increasing the molecular weight and branching of the molecules will increase the bonding strength.

2. Inter diffusion of molecules: As a function of time, temperature and pressure, miscible molecules exhibits diffusion ea ch other. Eg. If one piece of raw Rubber kept on another piece of Rubber, they become increasingly difficult to separate over a period of time.

3. Wetting or spreading: The wetting of a solid by liquid is characterized in terms of angle θ of contact that made liquid on the solid. The totally free spreading, the angle of wetting is zero.

Liquid wetting of a solid surface

YSV = YSL + YLV Cos θ.

YSV = Solid vapor surface tension, YSL = Solid liquid surface tension, YLV = liquid vapor surface tension

The ability to spread (wet) or spreading (wetting) pressure (S) is a measure of the ability of the liquid to wet and spread on a solid surface and it is related to the surface tensions of solid, liquid and vapor.

Here a liquid epoxy resin is applied to the surface of the solid PE and cured. The adhesion will be very poor. But in case the molten PE is applied to a cured epoxy adhesive the adhesion will be very strong. The reason is, in first case, the surface tension of solid PE (YS) is low, liquid epoxy (YL) is high and YV is a constant. Hence YSV and YSL are low and YLV will be high. Hence S is low, that means the adhesion will be low. In second case surface tension of molten liquid PE (YL) is low and cured one solid epoxy resin (YS) is high! Hence S is high, and the adhesion also will be high!!

Let us see a very interesting case as an example

4. Elastic nature of adhesive: Reducing the brittleness in an adhesive material can absorb the shocks and reduces the bond fracture. For this reason, most adhesives contain Rubbery Polymer as part of their formulation.

In Rubber industries, most of the adhesion process of elastomers involves as bonding with metal and fabric. As coupling, it functions with inorganic fillers in Rubber compounds. But latest developments like applications of Titanates/ Zirconates in Rubber compounds can lead into the possibilities of coupling effect with carbon black fillers also.

ELASTOMERIC COMPOUND CHARACTERISTICS FOR BONDING:

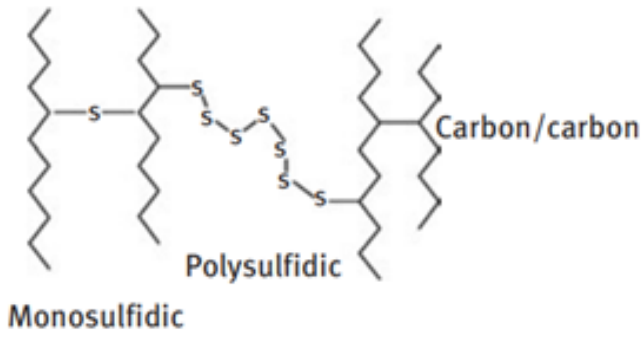
Base Polymer:

Polarity and unsaturation are two major characteristics which are having influence on bonding system. As unsaturation increases, the availability of reactive site will increase and bonding also increases. As the polarity increases, the wettability will increase and bonding increases.

Influence of Vulcanization system of a compound:

Sulfur Cured Compounds:

In sulfur vulcanization system, higher the sulfur and polysulfidic cross links gives higher the bonding strength

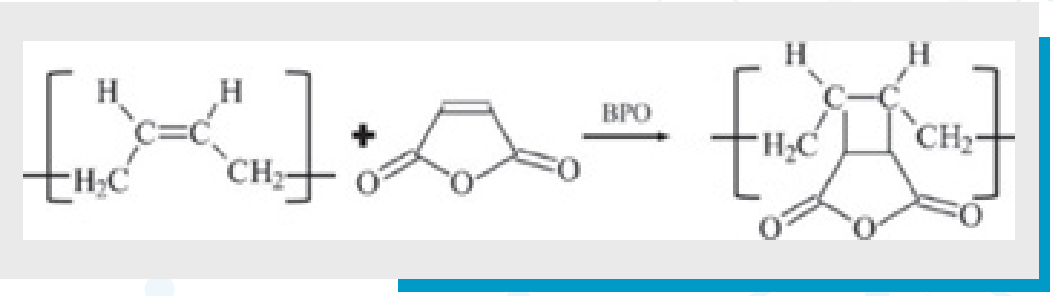


Higher the sulfur and lower accelerator type (Conventional vulcanization system) gives higher bonding strength with metal / fabric substrates. In that also accelerator MBTS gives maximum bonding (Sulfur >2.5pphr and MBTS = 0.6pphr) and followed by CBS (Sulfur >2.5pphr and CBS = 0.6pphr). The MBTS 0.4pphr + DPG 0.2pphr with sulfur >2.5pphr also gives excellent bonding characteristics.

Maleic-anhydride as an internal adhesion promoter:

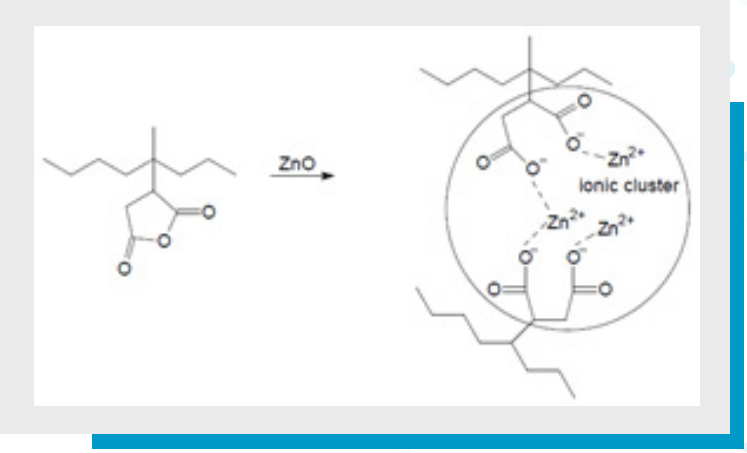
The use of maleic-anhydride grafted low molecular weight liquid Poly butadiene (LPBd), typically at 10.0pphr will increase the adhesion of sulphur cured Rubber compounds.

Grafting maleic-anhydride to the Polybutadienes increases the polarity of the Polymer. Few of C = C bonds of Poly butadiene molecule are used to attach the maleic group to the Polymer back bone and others are still available to form cross links during curing.



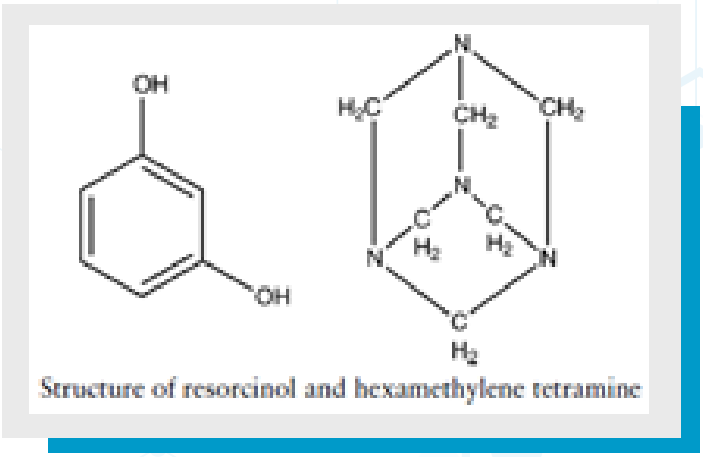
Grafting of maleic-anhydride with Poly butadiene

The zinc oxide in the Rubber compound will activate the reaction by opening the maleic-anhydride ring and the form cross links and cross bridges within the Rubber as well as between Rubber and substrates.



Resorcinol with a methylene donor as an internal adhesion promoter:

Resorcinol in combination with a methylene donor such as hexamethylene tetra amine (HMT) with hydrated silica as a filler in compounds containing cobalt salts (Cobalt naphthanate) improves the adhesion of the Rubber Compound with substrates. On heating, HMT decomposes to produce formaldehyde that reacts with the resorcinol to produce a stable, highly cross linked polymeric network. The general dosage of Resorcinol is 1.0 to 4.0pphr and HMMM also 1.0 to 4.0pphr. The sulphur should be 4.0 to 6.0pphr. MBTS can be used as an accelerator with Zinc oxide + Stearic Acid as an activator system. The cobalt salt will be 0.1 to 0.3pphr and Silica will be 10.0 to 50.0pphr.

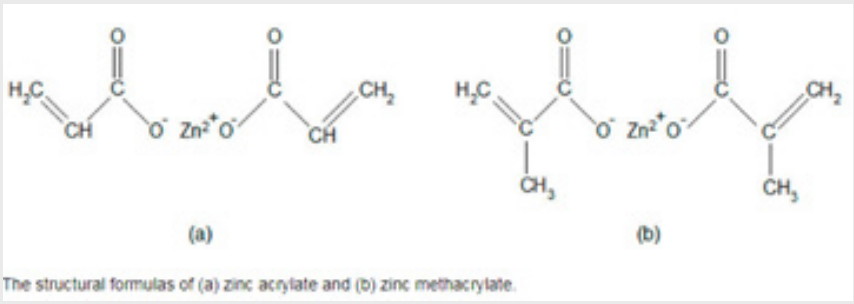


Structure of resorcinol and hexamethylene tetramine

Peroxide Cured Compounds:

Metallic co agents are typically multifunctional monomers that are highly reactive in the presence of free radicals formed during decomposition of organic peroxides,

and readily graft to Rubber molecule to form a Polymeric cross link network. Hence it is used to improve the efficiency and cross link density in peroxide cross linking system. Metallic (Zinc) salts of acrylic acid and methacrylic acid are used as such co agents in peroxide curing system, which will improve Rubber to metal / fabric / substrates bonding strength.



The structural formulas of (a) zinc acrylate and (b) zinc methacrylate.

The C – C bond in peroxide curing system and C – Sx – C bond in polysulfidic curing system will be having their own limitations of advantages and disadvantages. The C – C bond will be a strong covalent bond provides good heat aging properties but due to its brittleness it exhibits lower tensile, tear and elongations. But in C – Sx – C cross links, polysulfidic bond is flexible than C – C bond, gives improved tensile, tear and elongation and due to its lesser bond strength, the resistance to heat degradation will be poor.

The crosslinks formed with metallic co agent in peroxide cured rubbers are ionic due to the zinc carboxylate bonds. These ionic bonds exhibit both good heat aged stability and the ability to slip along, characteristics of both the peroxide and sulphur crosslink systems, giving high tensile and tear strength and excellent heat aged properties.

1. RUBBER TO METAL BONDING

The interesting subject in this topic is the surface chemistry of metals. Due to the environmental influences the metal surface is not a 100% pure metal! It contains a layer of metal hydroxide and metal oxides! Here the metal hydroxides (M – OH) are surface end of metal molecules where the – OH group bonded with metal through a strong covalent bond and this surface nature participates in Rubber to metal bonding process. The metal oxides are weakly bonded with metal surface and are removed during surface preparation before Rubber bonding.

History of Rubber to metal bonding :

Ebonite bonding:

The history of Rubber to metal bonding starts from ebonite bonding technique. High loading of elemental sulphur in ebonite compound will hold the metal surface and develop a bonding strength. The sulphur in the Rubber will react with metal hydroxide M – OH to form a bonding. By applying a series of adhesive coats with decreasing sulfur contents. The sulfur content is reduced with increasing distance from the metal surface. This creates a decreasing modulus gradient between the rigid steel and soft Rubber. But due to thermoplastic nature of this bond, a boundary of temperature limit was the major disadvantage of this system. This bond can withstand maximum 60 to 70°C.

Brass coated metal surface:

An electro deposited brass on the metal surface will more interact with sulphur containing in Rubber compound which will improve the bonding. The brass contains 70% of copper and adhesion is obtained by the interaction between this copper and sulphur. A cobalt salt such as cobalt naphthanate in the Rubber compound will further improve the adhesion. Thermal properties of these bond is better than ebonite system. But the galvanic plating process required to deposit this brass on the metal surface is an expensive investment for the industries.

Modern rubber to metal adhesive chemistry:

The modern adhesive system is broadly categorized into three types.

1. Primer + Adhesive cover coat system.
2. Single coat system
3. Silane based Special system

Primer + cover coat system:

Adhesion through developing a progressively softer layers starting from metal surface towards Rubber involves following functions.

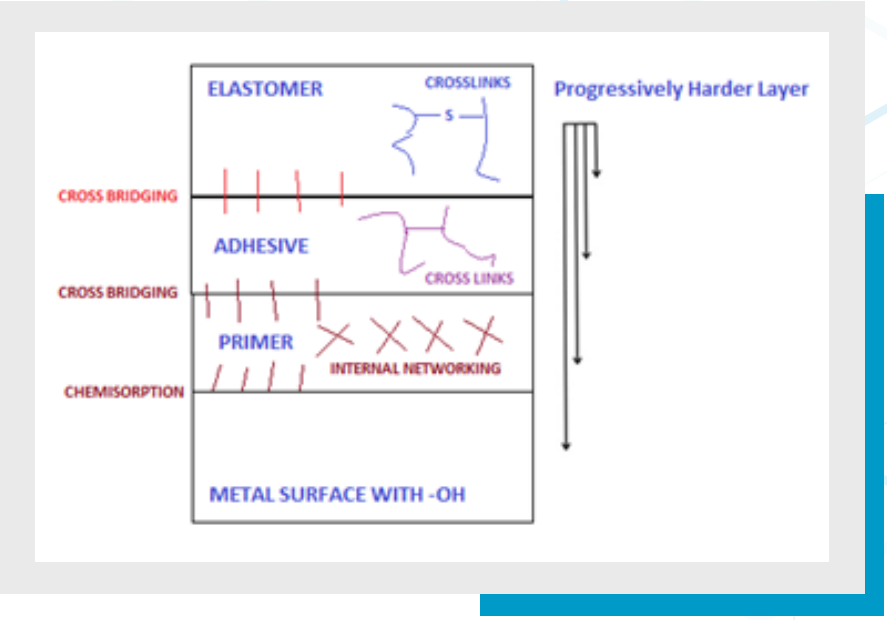
1. Chemisorption: It is a reaction between primer and metal substrate surface to form a strong chemical bond.

2. Internal networking: It is a reaction within the primer matrix to develop a surface that adhesive cover coat can form cross bridge. A self-cross linking resin will perform this.

3. Cross bridging through adsorption and / or inter diffusion: It is a reaction to form a chemical bond between opposite sides of an interface (primer to adhesive cover coat or adhesive cover coat to Rubber matrix) through a di functional molecule (cross bridging agent)

4. Cross linking: It is an internal chemical bond forming between Rubber molecules present in the adhesive cover coat or Rubber materials through a cross linking agent having two or more functionality.

The primer performs internal networking, chemisorption with substrates and cross bridging with adhesive cover coat. The adhesive cover coat performs internal cross linking, and cross bridging through adsorption and / or inter diffusion with both primer and Rubber matrix. Along with this the Rubber compound performs internal cross linking. The entire system will develops a modulus gradient or forms progressively harder layers from Rubber towards the bondable substrate, along with chemical bonds. This will result in bond between Rubber and substrate.



Elements of Primer + Cover coat system:

Primer

Primers typically contain:

- Epoxidized phenolic resins with an epoxy resin curing agent to develop chemisorption bond to the metal surface,
- A halogenated polymers such as chlorinated natural rubber functioning as additive to reduce brittleness of the epoxidized phenolic resin and to react with the adhesive cover coat. More heat and oil resistant primers can be made using chlorinated polyolefins or neoprene (Polychloroprene) as the film-forming polymer
- Metal oxides as acid acceptors.
- Fillers

All are either dissolved in a solvent or dispersed in an aqueous carrier. The primer may also contain such things as phenoxy resins and/or silanes.

Adhesive cover coat

The adhesive cover coat contains:

- a halogenated polymer (as a film former),
- inorganic acid stabilizers,
- co-curatives and cross linkers,
- and hot tear strength promoters,

All are dispersed in a solvent or aqueous carrier.

The earliest versions of adhesives had only a minimal number of ingredients. They

were made by dissolving chlorinated natural rubber and poly 2,3-dichloro-1,3-butadiene or brominated 2,3-dichloro -1,3-butadiene polymer along with a Polyisocyanates as cross linking agent in solvent.

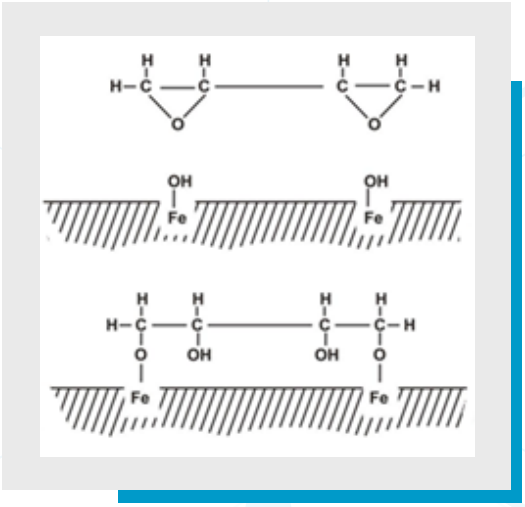
Shortly thereafter, the Polyisocyanates was replaced with a dinitroso aromatic compound as the primary crosslinking and cross bridging agent. The preferred chemical is highly reactive dinitrosobenzene (or DNB) which is still heavily used in adhesive cover coat for organic rubber today.

As technology moved toward aqueous adhesives, chlorinated polymers continued to be used as the film-formers, but in latex form. Some latexes that were used were 2,3-dichloro-1,3-butadiene, chlorinated ethylene/ vinyl acetate copolymer, chlorosulfonated polyethylene, and other chlorinated polyolefins. The preferred crosslinking additive continued to be DNB although other additives have been disclosed including quinone dioxime (QDO) and polymaleimides.

CHEMISTRY OF SOME POSSIBLE REACTIONS DURING CURING OF TOTAL RUBBER TO METAL BONDING TWO COAT SYSTEM:

1. A possible reaction of chemisorption and wetting in primer to metal surface:

Fundamentally the hydroxyl group of phenolic resin modified with epoxy rings is called as epoxidized phenolic resin. This added functionality increases the reactivity of resin. The epoxy reactive site will react with – OH group of metal surface and form chemisorption.



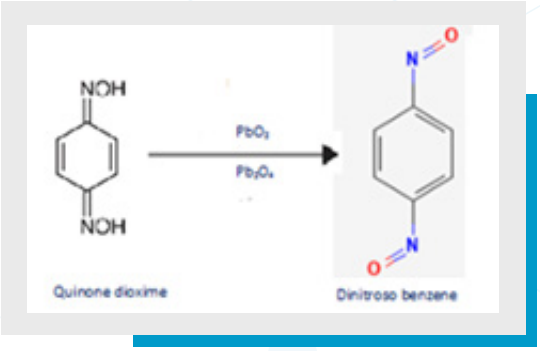
A possible chemisorption with metal surface through epoxy group of epoxidized phenolic resin.

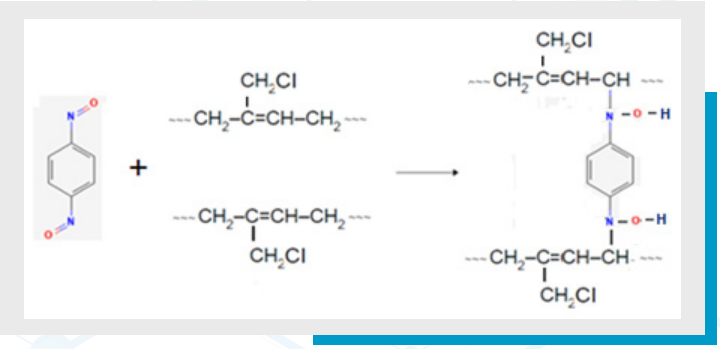
2. nternal networking through cross linking of epoxidized phenolic resin:

The presence of suitable heat reactive cross linking agent develops cross link network between epoxy reactive sites of epoxidized phenolic resin matrix and polymerizes, which will form a surface barrier with halogenated Rubbery Polymer such as chlorinated natural Rubber. Along with this the halogenated Rubbery Polymer content will give a small flexibility or relaxation from the rigidity of the resin to the primer layer affecting decreased modulus gradient. An interlocked structure of molecules of these halogenated Rubber with the cross link network of epoxidized phenolic resin Polymer form a primer surface and will provide provision for cross bridging with adhesive cover coat.

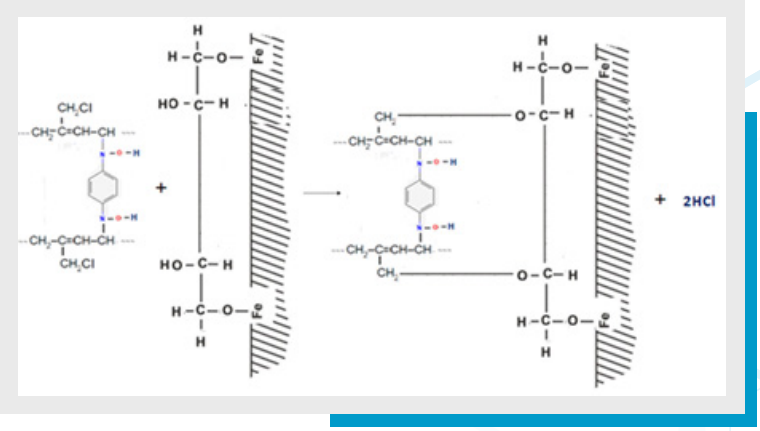
3. Curing of halogenated Rubber affect in cross links within adhesive layer, cross bridging with primer as well as Rubber:

Halogenated Rubber is used to achieve maximum wetting. In curing temperature, in the presence of PbO2 and Pb2O4, the Quinone dioxime (QDO) becomes highly reactive Dinitroso benzene (DNB) and it will form cross link with halogenated Rubber. This reaction develops internal cross links within the adhesive cover coat matrix and the cross bridging with primer coat layer is an interesting part of the reaction possibility. The – CH2Cl site of the cross linked halogenated Rubber forms bond and creates cross bridges with – OH site of metal bonded epoxy molecules in the primer coat. Here the HCl will be generated which will be neutralized by acid scavengers. This bond will add up the strength of cross bridges formed by additional DNB cross linking of halogenated Rubber molecules of primer coat. The DNB also reacts with Rubber compound having contact with adhesive cover coat and form strong cross bridges. In this manner a strong bond develops Metal to primer, Primer to Adhesive and Adhesive to Rubber.





Cross linking reaction within adhesive coat, with primer coat and with Rubber matrix.



Cross bridging reaction with primer coat.

4. Cross bridging between Rubber and Adhesive cover coat layer:

DNB in the adhesive cover coat will form cross bridge with Rubber as well as Sulfur + Accelerator system will form cross bridge from Rubber to adhesive cover coat.

Acid neutralization:

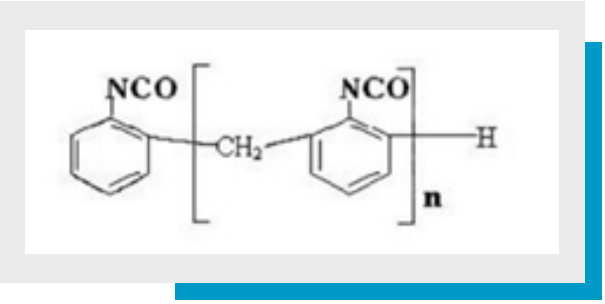
This is a supporting reaction to the above. The halogenated Rubber containing in primer and adhesive cover coat will generate acid molecules during cross linking reactions. This acid will retard the reactions and affect adversely in the adhesion. Some inorganic oxides and / or some lead containing polybasic salts are used to neutralize this acidic substances. Few of these substances used in both primer and adhesive cover coat are described as below.

Acid acceptor	Metal oxides	Zinc oxide, Cadmium oxide, Magnesium Oxide, Red lead, Litharge, Zirconium salts
	Lead containing compounds such as Polybasic lead salts of phosphorous acid and saturated and unsaturated organic di carboxylic acids and acid anhydrides.	Dibasic lead phthalate, Monohydrous tribasic lead maleate, Tetrabasic lead fumarate, Dibasic lead phosphite
	Other lead containing compounds	Basic lead carbonate

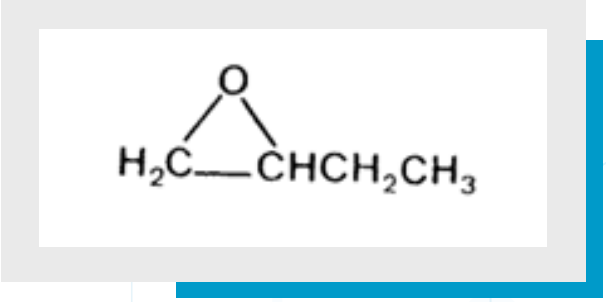
1. SINGLE COAT SYSTEM

This system contains very large amounts of something ingredients designed to act as both the primer and adhesive cover coat in one single package.

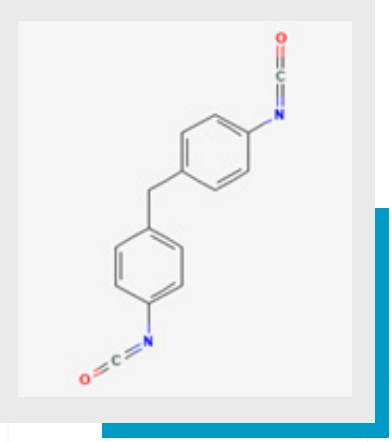
Generally in this system, the chemisorption is performed by a mixture of few organic isocyanates such as: Aromatic Polyisocyanates, 4, 4 diphenyl methane di isocyanates, 2, 4 diphenyl methane di isocyanates, with a small amount of an epoxy monomer such as 1, 2 epoxy butane.



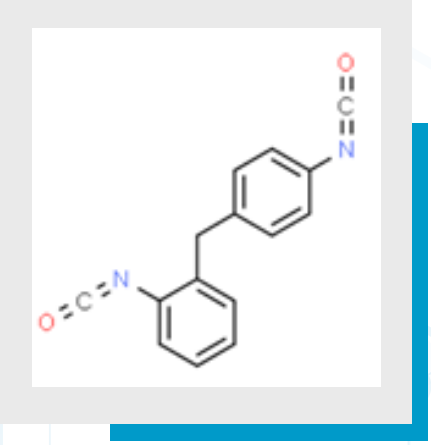
Aromatic Polyisocyanates



1, 2 epoxy butane



4, 4 diphenyl methane di isocyanates

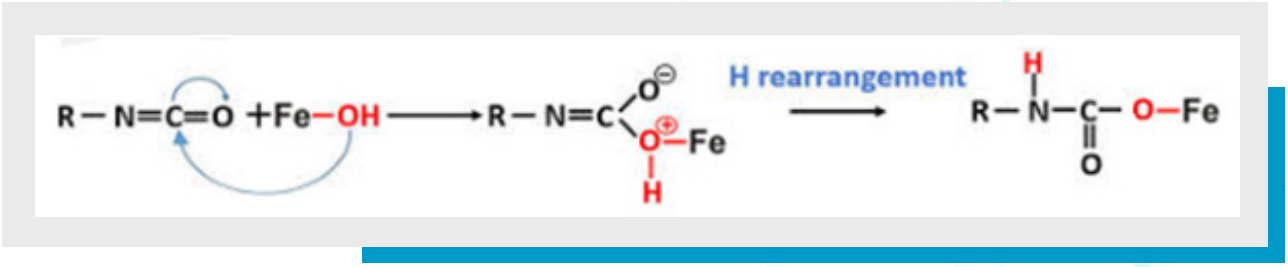


2, 4 diphenyl methane di isocyanates

Film forming and cross bridging are performed by a presence of a chlorinated elastomeric combination such as a mixture of chlorinated natural Rubber and chlorosulfonated polyethylene (CSM) with a cross linking agent such as dinitroso benzene (DNB) yielding Quinone dioxime.

An acid acceptor such as Lead oxide phosphonate will be used to neutralize the HCL formed during cross linking of halogenated elastomer.

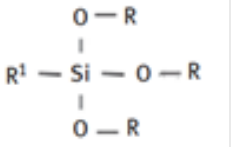
Carbon black used as a filler.
All the above are dissolved in a solvent mixture such as Trichloroethylene + Xylene + Ethyl benzene



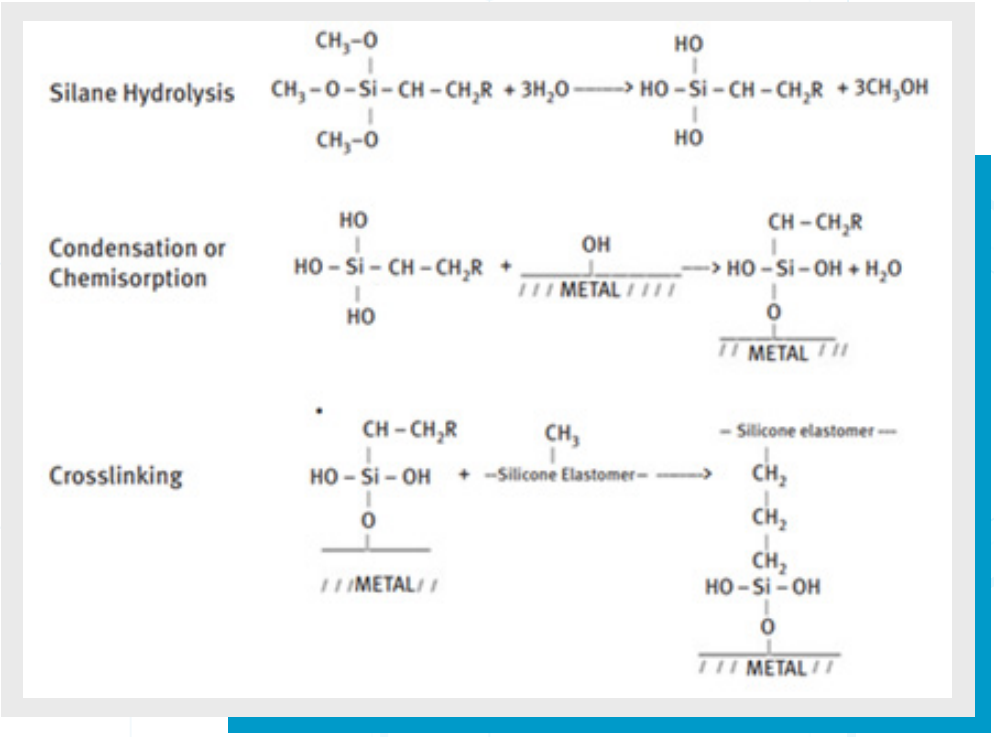
Chemisorption by organic isocyanates

2. SILANE BASED SPECIAL SYSTEM

Specialty elastomers like Silicone Rubber, ACM, AEM, FVMQ, FKM, are bonded using silane chemistry. The structure of silane is as below.



The silane having one organophilic group R1 and three inorganophilic group with silicone atom. The inorganophilic group bonds with – OH groups on the surface of the metal after hydrolysis. The organophilic end will bond with Rubber matrix.



Hydrolyzable groups in the silane are commonly either methoxy or ethoxy. Bonding reaction occurs in three steps. Silanes are moisture sensitive. During the hydrolysis step, the silane reacts with three water molecules to split off methyl or ethyl alcohol. When the metal part is dipped into the primer, the – OH groups on the silane can condense with – OH groups on the metal to form bond or chemisorption. During Rubber crosslinking reaction, the organophilic group will bond with Rubber matrix.

For silicone and some other specialty Rubber having peroxide curing system, the organophilic group will be vinyl. For FKM it will be amino or glysidoxy.

Before using the silane it is diluted, pre hydrolyzed and stabilized.

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Consultant – Rubber Technology and Lead Auditor ISO 9001:2015

COMPARISON OF SULPHUR AND PEROXIDE CURE SYSTME IN EPDM RUBBER

The key difference between sulphur and peroxide cure is that sulphur cured EPDM shows low chemical and thermal resistance compared to the peroxide cured EPDM.

The term EPDM stands for Ethylene Propylene Diene Monomers. It is a type of high-density synthetic rubber. Generally, this material is not heat resistant compared to materials such as silicone, but it can withstand high temperatures that are up to about 130 Celsius degrees. Therefore, we can do sulphur curing and peroxide curing to enhance this property of chemical and thermal resistance.

What is Sulphur Cure?

Sulphur is a chemical element having the chemical symbol S and atomic number 32. It is a polyatomic nonmetal having the electron configuration [Ne]3s23p4. This is an abundant, multivalent, and non-metallic chemical substance that occurs in two major forms as organic sulphur and inorganic sulphur. We can use this nonmetal for the production of sulphur cured EPDM.

EPDM or Ethylene Propylene Diene Monomer is a popular and versatile rubber compound that is commercially available. The most concerning properties of EPDM are outstanding heat, ozone, and weather resistance. We can subject this material to curing with either sulphur or peroxide. Here, we need to choose the proper material and method for curing based on the end-use and its application.

Generally, sulphur cured EPDM is common and readily available compared to peroxide cured EPDM. Moreover, this material is generally more commercially attractive. However, it can withstand temperatures up to about 250 degrees Fahrenheit, which is comparatively a low value. Furthermore, sulphur cured EPDM is higher in tensile strength, has a high tear strength, and permits us to use it in a wide range of fillers

What is Peroxide Cure?

Peroxide is a reactive chemical species in which two oxygen atoms are linked together with a single covalent bond. There are several peroxides that are common as bleaching agents. We can use peroxides to get peroxide cured EPDM.

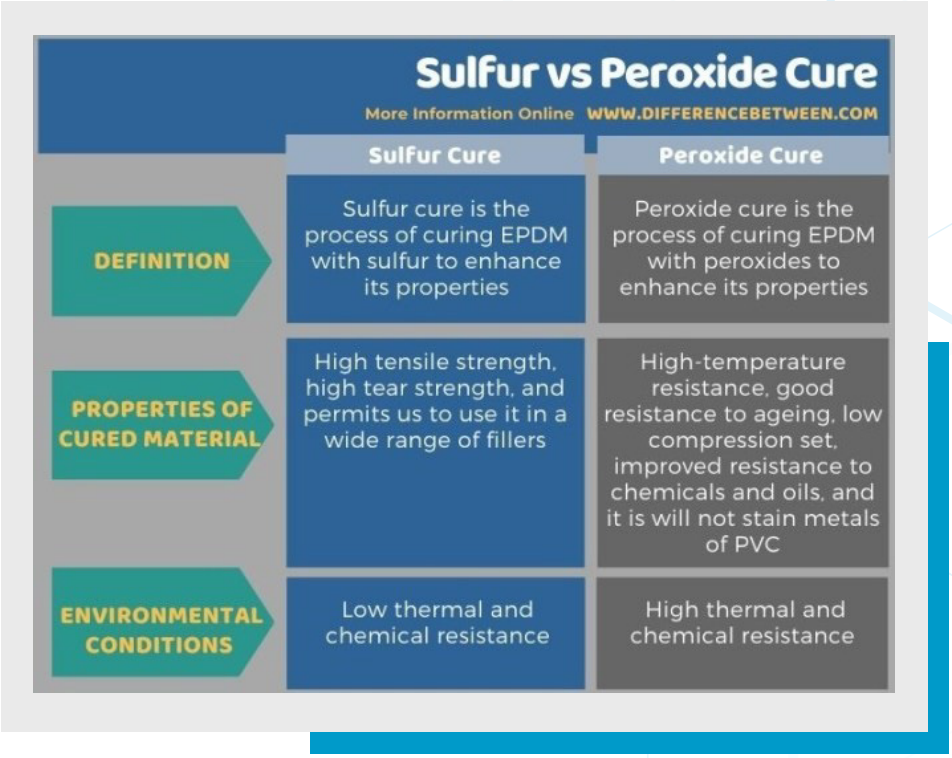
In general, EPDM that is cured with peroxide has a superior chemical and thermal resistance compared to sulphur cured EPDM. The peroxide cured EPDM is able to withstand temperatures up to 300 degrees Fahrenheit. Moreover, it can improve the compression set and ageing resistance of the material.

Furthermore, peroxide cured EPDM has high-temperature resistance, good resistance to ageing, low compression set, improved resistance to chemicals and oils, and it will not stain metals or PVC.

What is the Difference Between Sulphur and Peroxide Cure?

We can do sulphur curing and peroxide curing to enhance the properties of EPDM by increasing chemical and thermal resistance. The key difference between sulphur and peroxide cure is that sulphur cured EPDM shows low chemical and thermal resistance compared to peroxide cured EPDM. Moreover, sulphur cured EPDM has high tensile strength, high tear strength, and permits us to use it in a wide range of fillers while peroxide cured EPDM has high-temperature resistance, good resistance to ageing, low compression set, improved resistance to chemicals and oils, and it is will not stain metals of PVC.

Below is a summary of the difference between sulphur and peroxide cure in tabular form.



Summary – Sulphur vs Peroxide Cure

The term EPDM stands for Ethylene Propylene Diene Monomers. It has a low thermal resistance, so we need to cure it to enhance its properties. We use sulphur curing and peroxide curing to enhance this property of chemical and thermal resistance. The key difference between sulphur and peroxide cure is that sulphur cured EPDM shows low chemical and thermal resistance compared to the peroxide cured EPDM.

PEROXIDE OR SULPHUR CURED EPDM - WHAT DOES YOUR APPLICATION NEED?

EPDM is one of the most popular and versatile rubber compounds available. The main properties of EPDM are its outstanding heat, ozone, and weather resistance.

During the manufacture of EPDM, the compound can be cured with either sulphur or peroxide. The choice of curing method is determined by the end-use and application.

EPDM cured with peroxide possess a superior chemical and thermal resistance compared to sulphur cured. Peroxide cured EPDM can withstand temperatures up to 300°F whereas sulphur cured can only resist temperatures up to 250°F. Peroxide curing also improves the compression set and aging resistance of the part.

Sulphur curing of EPDM is more common, more readily available, and generally more commercially attractive.

Peroxide cured EPDM

- Higher temperature resistance
- Good resistance to aging
- Lower compression set
- Improved resistance to chemicals and oils
- Will not stain metals or PVC

Sulphur cured EPDM:

- Higher tensile strength
- Higher tear strength
- Permits use of a wider range of filler

By
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Bio-plastics: The Future of Sustainable Materials

Bio-plastics have been for the last couple of years the most promising alternative to traditional plastics that have long been in the news due to causing environmental dangers. Bio-plastics are derived from renewable biomass sources such as plants, agricultural wastes, or microbial-based approaches and therefore mark the end to plastic waste in our surroundings. This is an essay on types, advantages, challenges, and the future of bio-plastics.

Types of Bio-plastics

Bio-plastics are classified under two categories.

1. Bio-based Plastics: They are derived from renewable biological sources. Examples are polylactic acid or PLA, which is produced by extracting corn starch and also polyhydroxyalkanoates that can be produced through microbial fermentation.

2. Biodegradable Plastics: These can be decomposed in particular environmental conditions. Not all biodegradable plastics can be termed as bio-based. Some examples are the following: PLA, PHA, and starch blends

Advantages of Bio-plastics

1. Environmental Advantage

- **Lower Carbon Footprint:** Bio-plastics are produced from renewable resources, hence it reduces dependence on fossil fuels and minor emissions of greenhouse gases.
- **Biodegradable:** Most bio-plastics can easily decompose due to natural environmental conditions, therefore reducing plastic wastes and pollution
- **Sustainability:**
- **Renewable Sources:** Biomass such as corn, sugarcane or algae is used, therefore enhancing sustainable agriculture.

- **Energy Conservation:** Some bio-plastics can be manufactured with relatively smaller quantities of energy compared to traditional plastics
- **Versatility:Flexibility:** Bio-plastics can be used for diverse purposes, including packaging, utensils, medical instruments, and even textiles.
- **Innovation Opportunities:** Further research on bio-plastics develops new types that have improved properties. Thus, the application areas for bio-plastics also grow.
- **Economic Benefits:**
- **Rural Economy:** The raw material that would be required for producing bio-plastics can stimulate rural economies and thereby offer employment.

Drawbacks of Bio-plastics

1. Costly:

- **Production Costs:** Bio-plastics are currently more expensive compared to regular plastics. At present, they will not sell easily when mass-produced.
- **Market Prices:** Bio-plastic products usually have higher market prices compared with other products when the materials and manufacturing processes increase.

2. Performance Limitations:

- **Durability:** Some types of bio-plastics are lacking in durability and multifaceted like ordinary plastics and are thus found in narrower scopes of applications.
- **Process Challenges:** Bio-plastics would have to be integrated into existing manufacturing processes, which increases costs and complexity.

3. Biodegradability Conditions:

- **Conditions for Biodegradation:** Not all bio-plastics are biodegradable in nature; they only biodegrade under industrial composting conditions.
- **Confusing Labeling:** Products labeled as biodegradable are not biodegradable in natural environmental conditions but are biodegradable in a controlled environment. This may lead to misuse and misapplication of the product.

4. Resource Competition:

- **Land:** Bio-plastic crop production competes with food crops, creating ethical and economic issues.
- **Water and Fertilizer Use:** Raw materials for bio-plastics have resource-intensive production processes, potentially affecting water and fertilizer use.

Future Outlook

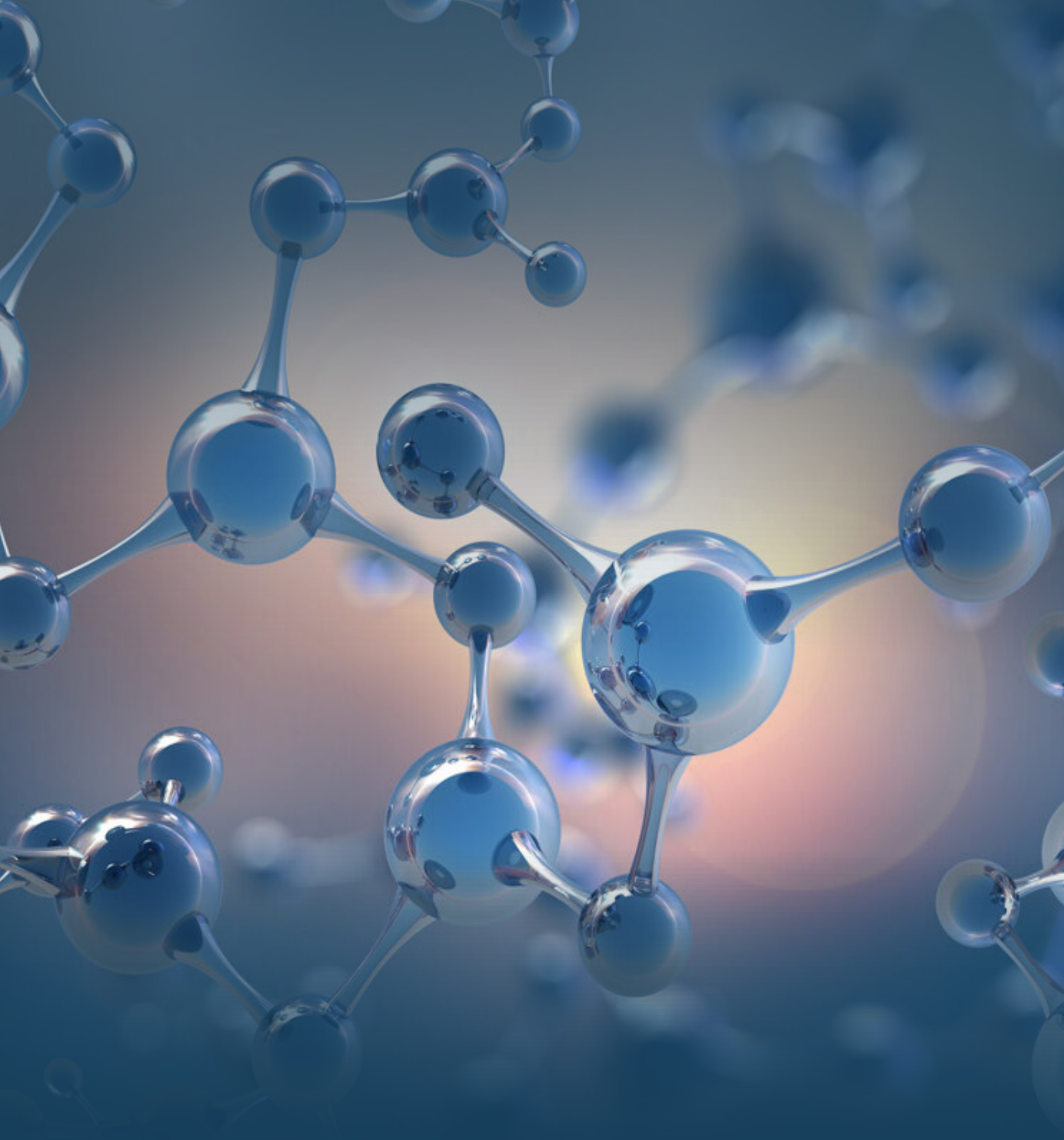
Future of bio-plastics seem bright with continuous researches and developments. Biotechnological and material science developments are expected to overcome the drawbacks of the present situation as bio-plastics will, therefore, be more competitive at cost and performance levels. A growing consumer awareness and good policies will, therefore, have a positive effect on demand as well as investment in this technology.

Bio-plastics are an important step in a future more sustainable and greener. Of course, there are many challenges to be overcome. Yet the process and the trend toward increasing sustainability will cement bio-plastics as part of the resolution of the crisis that plastic brings globally. Here's bio-plastics-for a cleaner greener, more sustainable world.

By

Shubhakar Nayak Gowrimoole

Coordinator, PAWA/PAWT



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