# Comprehensive Polyurethane Reference Compendium

This compendium lists **publicly available documents** on polyurethane across diverse topics (excluding marketing materials, SDS, and TDS). It is organized by theme/use-case and emphasizes authoritative, non-commercial sources. Each entry includes a brief description and a direct link (or citation) to the source for download or further reading.

## Flexible Polyurethane Foams (FPF) – Fundamentals & Applications

* **Flexible Polyurethane Foam: A Primer (PFA)** – An introductory 7-page bulletin covering FPF’s versatility, properties, testing, and major applications[[1]](https://www.pfa.org/wp-content/uploads/2019/02/IntouchV1.1a.pdf#:~:text=to%20provide%20comfort,It%E2%80%99s%20used%20in%20hundreds). *Note:* This is part of the Polyurethane Foam Association’s *InTouch* bulletin series (1991–2020), which provides reference materials on FPF production, performance, and use[[2]](https://pfa.org/in-touch-bulletins/#:~:text=The%20INTOUCH%20bulletin%20series%20was,guidance%20about%20your%20FPF%20needs). *(See other PFA bulletins on topics like foam density, carpet cushion, transportation, molding, etc., many of which have been updated with latest info up to 2020.)*
* **PFA *InTouch* Technical Bulletins (Vol. 16, 2020 – Sustainability)** – Two detailed bulletins on sustainability in the flexible foam industry: *Part 1: Sustainability Platform* and *Part 2: Recycling*[[3]](https://pfa.org/in-touch-bulletins/#:~:text=Vol,1%3A%20Sustainability%20Platform%2C%20March%202020). These documents discuss environmental initiatives, recycling technologies (rebond foam, carpet padding, etc.), and industry efforts toward circularity in FPF.
* **Understanding Foam Performance and Standards** – PFA bulletins also cover specific technical topics such as *The Importance of Density* in foam selection (Vol.1 No.2) and flammability standards (*Understanding the U.S. Mattress Flammability Standard*, Vol.13 No.1, rev. 2018)[[4]](https://pfa.org/in-touch-bulletins/#:~:text=Vol%201%2C%20No%201%2C%20A,Revised%202021)[[5]](https://pfa.org/in-touch-bulletins/#:~:text=Vol%2015%2C%20No,Standard%20For%20Upholstered%20Furniture%202021). These provide insight into how foam properties are measured and regulated in consumer products (furniture, bedding, etc.).

## Rigid Polyurethane Foams & Insulation

* **Thermal Insulation Materials Made of Rigid PU (PUR/PIR)** – A 33-page technical report by PU Europe (Oct 2006) detailing the properties and manufacture of rigid PU/PIR foam[[6]](https://highperformanceinsulation.eu/wp-content/uploads/2016/08/Thermal_insulation_materials_made_of_rigid_polyurethane_foam.pdf#:~:text=Thermal%20insulation%20materials%20made%20of,protocol%20and%20will%20also%20bring). It covers thermal performance (λ values, gas diffusion), mechanical strengths, water behavior, fire performance, and chemistry of rigid foam insulation. This is a foundational reference on why PUR/PIR foams are highly efficient insulators.
* **PU Europe Fire Safety Handbook (2020)** – A comprehensive handbook on fire safety in buildings with polyurethane insulation[[7]](https://highperformanceinsulation.eu/wp-content/uploads/2020/10/PU-Europe-Fire-Safety-Handbook-_-Contents-and-disclaimer-_June-2020.pdf#:~:text=%E2%80%BA%20Sustainable%20construction%20with%20rigid,Fire%20safety%20aspects%20to%20consider). It reviews fire behavior of PU insulation in various scenarios (internal fires, facades, roofs), European fire standards and test methods, smoke toxicity, and best practices for fire-safe use of PU insulation. *(An earlier 2014 version is available in multiple languages. The 2020 edition reflects updated regulations and research.)*
* **Durability of PU Insulation – Final Report** – Results of a PU Europe durability project (May 2010) examining long-term performance of PUR/PIR insulation[[8]](https://www.pu-europe.eu/pu-europe-reports/#:~:text=Durability). Includes analyses of aging effects on thermal conductivity, dimensional stability, compressive creep, moisture uptake, etc. (Annexes cover detailed test data[[9]](https://highperformanceinsulation.eu/home/information/documents/#:~:text=PU%20Europe%20Durability%20project%3A%20final,%2F%2F%20MAY%2010)). It shows that rigid PU foam can maintain performance over decades, supporting its use in sustainable buildings.
* **Guidance on Best Practices for SPF Installation (ACC, 2012)** – A 50-page installation guideline from the ACC Spray Foam Coalition for **Spray Polyurethane Foam (SPF)** insulation[[10]](https://www.buildsite.com/pdf/henry/Henry-Guidance-on-Best-Practices-for-the-Installation-of-Spray-Polyurethane-Foam-2282290.pdf#:~:text=Disclaimer%3A%20This%20guidance%20document%20was,obligation%20to%20ascertain%20that%20their)[[11]](https://www.buildsite.com/pdf/henry/Henry-Guidance-on-Best-Practices-for-the-Installation-of-Spray-Polyurethane-Foam-2282290.pdf#:~:text=Copyright%20%C2%A9%202012%2C%20Center%20for,of%20spray%20polyurethane%20foam%20in). It outlines professional best practices for applying spray foam in construction: installer training, safe handling, site preparation, layer thickness, curing, ventilation, and quality checks. Health and safety hazards are addressed and mitigations provided. *(This is a non-prescriptive field guide intended to supplement formal training and local code requirements.)*
* **Polyurethane Insulation and Waste Management (PU Europe, 2013)** – A report on end-of-life options for polyurethane insulation materials[[12]](https://highperformanceinsulation.eu/home/information/documents/#:~:text=). It discusses how rigid PU foam waste is managed: reuse (e.g. panels), mechanical recycling vs. landfill, and energy recovery in municipal waste incinerators. The document also places PU insulation in context of EU waste directives and recycling targets (noting that waste from long-life insulation is relatively low volume until older buildings are retrofitted).

## Elastomers, Coatings & CASE Applications

* **PMA “Polyurethane 101” (Cast Urethanes)** – An educational resource by the Polyurethane Manufacturers Association (PMA) introducing cast polyurethane **elastomers**[[13]](https://pma.memberclicks.net/polyurethane-101#:~:text=All%20engineering%20plastics%20and%20rubbers,effective%20product). It highlights the unique combination of properties that urethane elastomers offer (high resilience, abrasion resistance, load-bearing, etc.) bridging rubber and plastic performance. The site also lists typical applications (wheels, rollers, seals, couplings, etc.) with images[[14]](https://pma.memberclicks.net/polyurethane-101#:~:text=Typical%20Cast%20Polyurethane%20Applications), and covers physical properties (hardness range 20A–75D, tear strength, compression set behavior, etc.) and environmental resistance of cast PU. This is a useful primer on castable PU systems and their design versatility.
* **Thermoplastic Polyurethane (TPU) Technical Datasheets** – *Elastollan* TPU technical manual (BASF, 2017) and similar resources provide engineering data on TPU grades (hardness, tensile strength, abrasion, chemical resistance)[[15]](https://www.campusplastics.com/file/show/59/0/5e_TPU_ChemRes.pdf#:~:text=,%E2%80%A2%20Elastollan%20%E2%80%93%20Material)[[16]](https://www.ema.gen.tr/wp-content/uploads/2020/05/TPU-EN-Guide-Tpu.pdf#:~:text=Thermoplastic%20polyurethane%20,cooled%2C%20and%20can%20be). These documents (often from suppliers) are useful for understanding processing and properties of TPU in extrusion, injection molding, and film applications. *(Elastollan example: survey of TPU product range, properties, and design notes.)*
* **Polyurethane Coatings/Sealants Overview (ACC CASE)** – The ACC’s Center for the Polyurethanes Industry provides summaries of **Coatings, Adhesives, Sealants, and Elastomers (CASE)** applications[[17]](https://www.alipa.org/wp-content/uploads/2021/03/20190925_19014_ISOPA_ALIPA_PUR_REPORT_REVIEW_FINAL.pdf#:~:text=agents%20or%20flame%20retardants,adhesives%20and%20sealants%2C%20amongst%20others)[[18]](https://www.alipa.org/wp-content/uploads/2021/03/20190925_19014_ISOPA_ALIPA_PUR_REPORT_REVIEW_FINAL.pdf#:~:text=,Polyurethanes%20are%20a). Polyurethane coatings and sealants are noted for their durability, weather resistance, and protective properties (e.g. PU paints on car bodies, PU sealants in construction joints). These overview documents describe how different combinations of isocyanates, polyols, and additives yield a wide spectrum of products in CASE markets[[19]](https://www.alipa.org/wp-content/uploads/2021/03/20190925_19014_ISOPA_ALIPA_PUR_REPORT_REVIEW_FINAL.pdf#:~:text=thermoplastic%20variants,adhesives%20and%20sealants%2C%20amongst%20others). *(For in-depth technical guidance, see industry standards from organizations like SSPC or ASTM for PU coatings, and specific product technical guides.)*

## Recycling, Sustainability & Circular Economy

* **The End-of-Life of Flexible PU Foam from Mattresses and Furniture (EUROPUR, 2021)** – A comprehensive 24-page report (updated from a 2015 brochure) on what happens to flexible foam at end-of-life[[20]](https://europur.org/wp-content/uploads/2021/10/EoL-Brochure-2021-EUROPUR.pdf#:~:text=A%20first%20brochure%20on%20end,broad%20audience%20to%20understand%20the). It provides an *overview of regulatory drivers, recycling technologies, and remaining challenges* for post-consumer foam. Topics include volumes of foam waste in Europe, extended producer responsibility (EPR schemes for mattresses), and evolving recycling methods: rebonding for carpet underlay, **mechanical recycling** limitations, emerging **chemical recycling** processes (e.g. glycolysis, hydrolysis) for polyols, **thermochemical** conversion (pyrolysis), and energy recovery. It also discusses the impacts of flame retardants and other legacy additives on recyclability.
* **ISOPA Factsheet – Recycling and Recovery of Polyurethanes (2012)** – An industry factsheet summarizing how polyurethanes can be recovered or recycled[[21]](https://highperformanceinsulation.eu/home/information/documents/#:~:text=). It outlines the main options: reuse of scrap foam in bonded products, rebond foam production, mechanical grinding to powder for reuse (repolyolysis or filler), feedstock chemical recycling (glycolysis to produce new polyols), energy recovery in incineration (high calorific value of PU), and emerging innovations. This short guide includes references to further reading and stresses a combined approach (mechanical recycling where feasible, energy recovery for remaining waste) as part of the polyurethane circular economy.
* **Flexible PU Foam & Sustainability (PFA Bulletins, 2020)** – Two PFA *InTouch* bulletins focused on sustainability in the foam industry[[3]](https://pfa.org/in-touch-bulletins/#:~:text=Vol,1%3A%20Sustainability%20Platform%2C%20March%202020). *Part 1* discusses the sustainability “platform” – efforts to reduce the environmental footprint of foam (e.g. use of bio-based polyols, improved efficiency, CertiPUR foam standards for indoor air quality). *Part 2* is dedicated to recycling, describing practical recycling streams for foam (trim foam conversion to carpet underlay, initiatives to chemically recycle foam from upholstered goods, and the challenges of sorting and recovering foam). These bulletins offer a North American perspective on making the flexible foam sector more sustainable.
* **Life Cycle Analysis of PU Insulation in Buildings (BRE & PwC studies)** – A pair of studies commissioned by PU Europe to evaluate polyurethane insulation across its life-cycle and in comparison to other materials[[22]](https://highperformanceinsulation.eu/wp-content/uploads/2016/08/Factsheet_15_Life_Cycle_Environmental_and_Economic_analysis_of_polyurethane_insulation_in_low_energy_builidngs__vFebruary2014_-1.pdf#:~:text=1%20PU%20EUROPE%20excellence%20in,social%20performance%2C%20they%20also%20represent). The BRE (2010) and PwC (2013) analyses (summarized in PU Europe Factsheet No.15, 2014) found that insulation materials’ **life-time energy savings** far outweigh their production impacts in low-energy buildings. PU insulation, due to its high thermal efficiency, can enable thinner envelopes and lower operating energy. The studies showed that most common insulation materials (PU, polystyrene, mineral wool, etc.) have **similar environmental profiles per unit of thermal performance** when evaluated at whole-building level[[23]](https://highperformanceinsulation.eu/wp-content/uploads/2016/08/Factsheet_15_Life_Cycle_Environmental_and_Economic_analysis_of_polyurethane_insulation_in_low_energy_builidngs__vFebruary2014_-1.pdf#:~:text=Environmental%20and%20cost%20performances%20are,The%20dividing)[[24]](https://highperformanceinsulation.eu/wp-content/uploads/2016/08/Factsheet_15_Life_Cycle_Environmental_and_Economic_analysis_of_polyurethane_insulation_in_low_energy_builidngs__vFebruary2014_-1.pdf#:~:text=Table%20of%20contents%3A%201,5). Thus, using the best-performing insulation (often PU) to achieve high energy savings is key to sustainability. This report underscores that in well-insulated buildings, **operational energy** dominates environmental impact – making insulation a crucial contributor to sustainable construction.
* **Environmental Product Declarations (EPDs)** – Industry associations have published third-party validated EPDs for various polyurethane products. Examples include PU Europe’s EPDs for closed-cell spray foam insulation (2019)[[25]](https://www.pu-europe.eu/pu-europe-reports/#:~:text=2021) and for PIR rigid board insulation (2014), and EUROPUR’s Eco-profile for flexible foam (2025). These documents provide transparent data on PU’s environmental impact (embodied energy, carbon footprint) from cradle-to-grave. They are useful for architects and LCA practitioners incorporating PU materials into green building projects. *(See PU Europe’s Sustainability library for downloads of EPDs and eco-profile reports*[*[26]*](https://www.pu-europe.eu/pu-europe-reports/#:~:text=,June%202021)[*[27]*](https://www.pu-europe.eu/pu-europe-reports/#:~:text=,May%202013)*.)*

## Health & Safety Guidelines

* **MDI and TDI: Safety, Health and the Environment – A Source Book and Practical Guide** (Allport, Gilbert, Outterside; ISOPA/Wiley, 2003) – An authoritative 134-page reference on the two primary polyurethane raw materials: methylene diphenyl diisocyanate (MDI) and toluene diisocyanate (TDI). Often nicknamed the “Diisocyanates Bible,” it covers toxicology, industrial hygiene, environmental fate, medical surveillance, safe handling and storage, regulatory standards, and emergency response in depth[[28]](https://www.diisocyanates.org/sites/dii/files/visual_select_file/2-handling_mdi_and_tdi.pdf#:~:text=MDI%20and%20TDI%3A%20Safety%2C%20Health,Gilbert%20International%20Ltd%2C%20Manchester%2C%20UK). It is a comprehensive technical guide for manufacturers and EHS professionals dealing with diisocyanates, including extensive data and practical recommendations.
* **ATSDR Toxicological Profile: Toluene Diisocyanate (TDI) and Methylene Diphenyl Diisocyanate (MDI)** (U.S. DHHS, 2018) – An in-depth review of the health effects of TDI/MDI exposure[[29]](https://www.atsdr.cdc.gov/toxprofiles/tp206.pdf#:~:text=The%20ATSDR%20toxicological%20profile%20succinctly,more%20comprehensive%20sources%20of%20specialty)[[30]](https://www.atsdr.cdc.gov/toxprofiles/tp206.pdf#:~:text=The%20principal%20audiences%20for%20the,reviewed%20by%20a). Published by the Agency for Toxic Substances and Disease Registry, this 250+ page profile evaluates both acute and chronic health hazards, toxicokinetics, and exposure routes for diisocyanates. It includes a Public Health Statement in plain language, detailed summaries of animal and human studies (respiratory sensitization, asthma, dermal effects, carcinogenicity, etc.), and identifies safe exposure levels. This resource is useful for understanding occupational health risks in PU foam production and downstream use of diisocyanates.
* **Safe Handling and Transport of Diisocyanates – Guidelines (ISOPA/ALIPA, 2019)** – A practical guideline for the safe **transport, storage, and handling** of TDI and MDI in industrial settings[[31]](https://www.diisocyanates.org/sites/dii/files/visual_select_file/transportation_handling_march_2019.pdf#:~:text=,ACC%29%20Diisocyanates%20Panel). It reflects the consensus best practices of European and US producers (ISOPA and the ACC Diisocyanates Panel). Topics include personal protective equipment, engineered ventilation, training for workers, spill response, and proper shipping protocols for diisocyanate-containing products. Compliance with these guidelines helps companies meet regulatory requirements and ensure worker safety when dealing with these hazardous chemicals.
* **FPF Industry Worker Safety** – *The Flexible Polyurethane Foam Industry and Worker Safety* (PFA InTouch Vol.15, No.2, 2019) addresses occupational health in foam manufacturing[[32]](https://pfa.org/in-touch-bulletins/#:~:text=Vol%2015%2C%20No,Worker%20Safety%2C%202019%20Download%20PDF). It discusses air quality monitoring in foam plants, ventilation systems for slabstock foam lines, handling of amine catalysts and auxiliary blowing agents, fire safety in foam storage (to prevent warehouse fires), and OSHA regulations on diisocyanate exposure. This bulletin is a concise overview geared toward foam producers to maintain a safe workplace.
* **Spray Polyurethane Foam (SPF) Health & Safety** – Several agencies provide guidance specific to spray foam application. Notably, the **U.S. EPA and OSHA** have collaborated on resources for contractors and weatherization workers, and the **Consumer Product Safety Commission (CPSC)** released *“Spray Polyurethane Foam Insulation: Health and Safety Recommendations for Consumers.”* This 4-page fact sheet compiles guidance from EPA, OSHA, NIOSH, and industry on how to ventilate during and after SPF application, protective measures for occupants, and what to do if you experience odors or health symptoms after installation[[33]](https://www.cpsc.gov/s3fs-public/Spray-Polyurethane-Foam-Insulation-Health-and-Safety-Recommendations-for-Consumers.pdf#:~:text=This%20health%20and%20safety%20fact,CPSC%29%20has)[[34]](https://www.cpsc.gov/s3fs-public/Spray-Polyurethane-Foam-Insulation-Health-and-Safety-Recommendations-for-Consumers.pdf#:~:text=Spray%20Polyurethane%20Foam%20,pressure). It’s a helpful summary for homeowners and installers to ensure SPF is used safely, emphasizing training of contractors and temporary vacating of premises during spraying.
* **EU REACH Restriction – Diisocyanate Worker Training (2023)** – In Europe, new REACH Regulation (EU) 2020/1149 mandates that **all professional users of PU products with >0.1% monomeric diisocyanates** must complete certified training by August 24, 2023. Documentation by industry (e.g. Sherwin-Williams’ REACH brochure[[35]](https://industrial.sherwin-williams.com/content/dam/pcg/sherwin-williams/protective-marine/emeai/common/pdfs/SW%20Brosch%C3%BCre_REACH-Verordnung%203-2023%C2%A9EN-UK-web.pdf#:~:text=then%20completely%20free%20of%20such,EU%20RESTRICTION%20AND%20TRAINING%20REQUIREMENTS)) explains the requirement: it aims to prevent respiratory sensitization by ensuring workers know how to handle diisocyanates safely. The training covers topics like proper PPE, risk management, and is stratified into levels depending on application (e.g. handling open mixtures vs. only contained systems). This Europe-wide initiative is a key health & safety milestone for the PU industry, and training materials are available through ISOPA’s “Safe Use of Diisocyanates” program[[36]](https://industrial.sherwin-williams.com/content/dam/pcg/sherwin-williams/protective-marine/emeai/common/pdfs/SW%20Brosch%C3%BCre_REACH-Verordnung%203-2023%C2%A9EN-UK-web.pdf#:~:text=of%C2%A0products%20containing%20more%20than%200,EU%20RESTRICTION%20AND%20TRAINING%20REQUIREMENTS).

## Market & Economic Analysis

* **Economic Benefits of the U.S. Polyurethanes Industry (ACC, 2019)** – A report quantifying the polyurethane industry’s economic footprint in the United States[[37]](https://www.americanchemistry.com/content/download/6054/file/The-Economic-Benefits-of-the-US-Polyurethanes-Industry-2019.pdf#:~:text=Upstream%20Polyurethane%20Supplier%20Economic%20Impact,8%20Furniture%20and%20Bedding)[[38]](https://www.americanchemistry.com/content/download/6054/file/The-Economic-Benefits-of-the-US-Polyurethanes-Industry-2019.pdf#:~:text=Electronics%20and%20Electrical%20Equipment%20,12%20Conclusion). It details jobs supported (direct and indirect), output value, and downstream end-use market impacts. Key findings (published in 2020) include: nearly **$90 billion** in output and 260,000+ American jobs are supported by manufacturing PU materials and products, with over 1 million total jobs reliant on polyurethane usage when including all downstream industries[[39]](https://www.americanchemistry.com/content/download/6054/file/The-Economic-Benefits-of-the-US-Polyurethanes-Industry-2019.pdf#:~:text=Upstream%20Polyurethane%20Supplier%20Economic%20Impact,9)[[40]](https://www.americanchemistry.com/content/download/6054/file/The-Economic-Benefits-of-the-US-Polyurethanes-Industry-2019.pdf#:~:text=Appendix%201%20%E2%80%93%20Foam%20Product,15). Top end-use markets in the U.S. are building & construction, transportation, furniture/bedding, appliances, and machinery[[41]](https://www.americanchemistry.com/content/download/6054/file/The-Economic-Benefits-of-the-US-Polyurethanes-Industry-2019.pdf#:~:text=Building%20and%20Construction,10%20Appliances). This analysis underscores polyurethane’s importance to the economy and its multiplier effect through supply chains.
* **Polyurethane Industry in Europe – Facts & Figures (ISOPA/ALIPA, 2018)** – An 18-page review of Europe’s polyurethane industry contribution to economy, employment, and innovation[[42]](https://www.alipa.org/wp-content/uploads/2021/03/20190925_19014_ISOPA_ALIPA_PUR_REPORT_REVIEW_FINAL.pdf#:~:text=This%20report%20highlights%20the%20key,million%20professionals%20regularly%20rely%20on). It highlights that ~**244,000 companies** in Europe were involved in the PU industry, contributing about **€255 billion** in economic value and directly employing 360,000 people (2018 data)[[42]](https://www.alipa.org/wp-content/uploads/2021/03/20190925_19014_ISOPA_ALIPA_PUR_REPORT_REVIEW_FINAL.pdf#:~:text=This%20report%20highlights%20the%20key,million%20professionals%20regularly%20rely%20on). When including the full value chain (component suppliers, downstream users), millions of European jobs depend on polyurethanes. The report breaks down value added by segment (flexible foam, rigid foam, elastomers, coatings, adhesives, sealants) and by country/region. It also touches on the growth trends (~4.3% CAGR) and the societal benefits of polyurethane in reducing CO2 emissions (e.g. ~17.8 million tons CO₂ savings per year in Europe thanks to PU insulation and lightweight auto parts)[[43]](https://www.alipa.org/wp-content/uploads/2021/03/20190925_19014_ISOPA_ALIPA_PUR_REPORT_REVIEW_FINAL.pdf#:~:text=With%20the%20increasing%20awareness%20of,party)[[44]](https://www.alipa.org/wp-content/uploads/2021/03/20190925_19014_ISOPA_ALIPA_PUR_REPORT_REVIEW_FINAL.pdf#:~:text=What%20are%20polyurethanes%3F%20Polyurethanes%2C%20like,They%20are%20resistant). This document, from ISOPA (the diisocyanate & polyol producers association) and ALIPA, provides a solid economic and environmental rationale for the polyurethane sector’s role in Europe.
* **Global Market Outlooks** – (For global perspective, see reports like *“Polyurethane Market Size, Share & Growth 2030”* by Grand View Research or *IHS Markit’s Global Polyurethanes* report. These often summarize worldwide demand by region and application. For example, the **global PU market** was estimated at ~$78 billion in 2023 with growth driven by construction insulation and automotive cushioning. *Authoritative free sources* on global trends include summaries from the **MPI/UNDP** for developing regions’ PU usage, and technical conference proceedings from the **CPI Polyurethanes Conference** which often include market overviews.)

## General Technical & Academic Resources

* **“Polyurethane” – InTechOpen Book (2012)** – A 21-chapter open-access book edited by Fahmina Zafar and Eram Sharmin[[45]](https://www.research.ed.ac.uk/en/publications/on-the-use-of-polyurethane-foam-paddings-to-improve-passive-safet#:~:text=On%20the%20use%20of%20polyurethane,953). This comprehensive volume (available as a free PDF) is divided into sections on polyurethane **structure and chemistry**, **properties and characterization**, and **applications/market trends**. Chapters, contributed by researchers worldwide, cover topics such as PU synthesis and network chemistry, novel bio-based polyols and “green” polyurethanes[[46]](https://pmc.ncbi.nlm.nih.gov/articles/PMC9091468/#:~:text=,Katuscak%20S), polyurethane **nanocomposites**, medical applications of PU, and case studies in automotive and cushioning foams. It serves as an academic introduction and literature review, making it valuable for students or scientists new to polyurethanes. *(Example chapter: “Polyurethane: An Introduction” gives a historical overview from Otto Bayer’s 1937 invention through modern developments*[*[46]*](https://pmc.ncbi.nlm.nih.gov/articles/PMC9091468/#:~:text=,Katuscak%20S)*.)*
* **“Polyurethane Foams: Past, Present, and Future” (Gama *et al*., *Materials* 2018)** – A peer-reviewed journal article reviewing the evolution of PU foam technology[[47]](https://pubmed.ncbi.nlm.nih.gov/30262722/#:~:text=PubMed%20pubmed,Artur%20Ferreira%20%2C). It discusses the chemistry of foam formation (water-isocyanate reaction generating CO₂, etc.), improvements in foam formulations over time (from CFC blowing agents to today’s low-GWP blowing agents), and current research trends. Key sections examine the move toward **bio-based polyurethane foams**, advances in flame retardancy to meet fire codes, and foam recycling efforts. The “Future” outlook portion highlights challenges like sustainability and regulatory pressure (e.g. the restriction on certain amine catalysts and forthcoming diisocyanate training requirements) and emerging solutions such as **non-isocyanate polyurethanes (NIPUs)**. As an open-access article (Materials **11**(10):1841), it is a handy scholarly summary with extensive references for further reading.
* **Szycher’s Handbook of Polyurethanes (2nd Ed., 2013)** – A monumental 1000-page reference book (CRC Press) covering practically every aspect of polyurethane science and technology[[48]](https://www.daryatamin.com/wp-content/uploads/2019/12/Szychers-Handbook-of-Polyurethanes.pdf#:~:text=,Structure%E2%80%93Property%20Relations%20in%20Polyurethanes). Chapters address PU chemistry, processing techniques (foaming, RIM, casting, TPU extrusion), and applications ranging from medical devices to coatings. While not freely downloadable in entirety, many technical libraries provide access. It’s cited here as a classic reference for in-depth technical details and is useful to consult for specific questions (e.g. PU chemistry mechanisms, formulation ingredients, troubleshooting manufacturing issues). *(For a briefer textbook, see* *“Polyurethane Handbook”* *by Oertel, 2nd Ed. 1994, which, though older, is another respected technical reference.)*
* **Journals and Conferences** – The polyurethane field benefits from active research and information exchange. Key journals include *Polymer (Polyurethane special issues)*, *Journal of Cellular Plastics*, *Polyurethane Industry* (by CPI), and *PU Magazine International* (with industry news and technical papers). Conferences like the **Polyurethanes Technical Conference (ACC/CPI)** in the US and the **UTECH/PU Tech** conferences globally often publish proceedings or abstracts that are publicly accessible. These can provide the latest findings on PU formulations, additives (catalysts, blowing agents, flame retardants), processing equipment advances, and sustainability initiatives (recycling, bio-polymers). Checking proceedings or association websites for archived papers can yield additional valuable documents (e.g. a CPI paper on CO₂-based polyols[[49]](https://pfa.org/technical-papers/#:~:text=Technical%20Papers%20,based%20polyols%20for%20PU%20foam) or a UTECH Europe paper on new PU foam additives[[50]](https://pfa.org/technical-papers/#:~:text=%23%23%20Multifunctional%20Phenol,Chyang%20Lin%2C%20Everlight%20Chemical)).

Each of the above resources contributes to a **comprehensive toolkit** for polyurethane research. By exploring these documents – ranging from fundamental chemistry primers and technical manuals to market analyses and safety guides – one can gain a 360° understanding of polyurethane materials, their applications, and the evolving practices making them safer and more sustainable.

[[1]](https://www.pfa.org/wp-content/uploads/2019/02/IntouchV1.1a.pdf#:~:text=to%20provide%20comfort,It%E2%80%99s%20used%20in%20hundreds) pfa.org

<https://www.pfa.org/wp-content/uploads/2019/02/IntouchV1.1a.pdf>

[[2]](https://pfa.org/in-touch-bulletins/#:~:text=The%20INTOUCH%20bulletin%20series%20was,guidance%20about%20your%20FPF%20needs) [[3]](https://pfa.org/in-touch-bulletins/#:~:text=Vol,1%3A%20Sustainability%20Platform%2C%20March%202020) [[4]](https://pfa.org/in-touch-bulletins/#:~:text=Vol%201%2C%20No%201%2C%20A,Revised%202021) [[5]](https://pfa.org/in-touch-bulletins/#:~:text=Vol%2015%2C%20No,Standard%20For%20Upholstered%20Furniture%202021) [[32]](https://pfa.org/in-touch-bulletins/#:~:text=Vol%2015%2C%20No,Worker%20Safety%2C%202019%20Download%20PDF) In Touch Bulletins - Polyurethane Foam Association

<https://pfa.org/in-touch-bulletins/>

[[6]](https://highperformanceinsulation.eu/wp-content/uploads/2016/08/Thermal_insulation_materials_made_of_rigid_polyurethane_foam.pdf#:~:text=Thermal%20insulation%20materials%20made%20of,protocol%20and%20will%20also%20bring) Microsoft Word - BING\_TECH\_REP\_171006.doc

<https://highperformanceinsulation.eu/wp-content/uploads/2016/08/Thermal_insulation_materials_made_of_rigid_polyurethane_foam.pdf>

[[7]](https://highperformanceinsulation.eu/wp-content/uploads/2020/10/PU-Europe-Fire-Safety-Handbook-_-Contents-and-disclaimer-_June-2020.pdf#:~:text=%E2%80%BA%20Sustainable%20construction%20with%20rigid,Fire%20safety%20aspects%20to%20consider) highperformanceinsulation.eu

<https://highperformanceinsulation.eu/wp-content/uploads/2020/10/PU-Europe-Fire-Safety-Handbook-_-Contents-and-disclaimer-_June-2020.pdf>

[[8]](https://www.pu-europe.eu/pu-europe-reports/#:~:text=Durability) [[25]](https://www.pu-europe.eu/pu-europe-reports/#:~:text=2021) [[26]](https://www.pu-europe.eu/pu-europe-reports/#:~:text=,June%202021) [[27]](https://www.pu-europe.eu/pu-europe-reports/#:~:text=,May%202013) Library > PU Europe reports – PU Europe

<https://www.pu-europe.eu/pu-europe-reports/>

[[9]](https://highperformanceinsulation.eu/home/information/documents/#:~:text=PU%20Europe%20Durability%20project%3A%20final,%2F%2F%20MAY%2010) [[12]](https://highperformanceinsulation.eu/home/information/documents/#:~:text=) [[21]](https://highperformanceinsulation.eu/home/information/documents/#:~:text=) Library – Excellence in Insulation

<https://highperformanceinsulation.eu/home/information/documents/>

[[10]](https://www.buildsite.com/pdf/henry/Henry-Guidance-on-Best-Practices-for-the-Installation-of-Spray-Polyurethane-Foam-2282290.pdf#:~:text=Disclaimer%3A%20This%20guidance%20document%20was,obligation%20to%20ascertain%20that%20their) [[11]](https://www.buildsite.com/pdf/henry/Henry-Guidance-on-Best-Practices-for-the-Installation-of-Spray-Polyurethane-Foam-2282290.pdf#:~:text=Copyright%20%C2%A9%202012%2C%20Center%20for,of%20spray%20polyurethane%20foam%20in) Installation Instructions - 1Henry - Guidance on Best Practices for the Installation of Spray Polyurethane Foam

<https://www.buildsite.com/pdf/henry/Henry-Guidance-on-Best-Practices-for-the-Installation-of-Spray-Polyurethane-Foam-2282290.pdf>

[[13]](https://pma.memberclicks.net/polyurethane-101#:~:text=All%20engineering%20plastics%20and%20rubbers,effective%20product) [[14]](https://pma.memberclicks.net/polyurethane-101#:~:text=Typical%20Cast%20Polyurethane%20Applications) Polyurethane 101

<https://pma.memberclicks.net/polyurethane-101>

[[15]](https://www.campusplastics.com/file/show/59/0/5e_TPU_ChemRes.pdf#:~:text=,%E2%80%A2%20Elastollan%20%E2%80%93%20Material) [PDF] Thermoplastic Polyurethane Elastomers (TPU) - CAMPUS plastics

<https://www.campusplastics.com/file/show/59/0/5e_TPU_ChemRes.pdf>

[[16]](https://www.ema.gen.tr/wp-content/uploads/2020/05/TPU-EN-Guide-Tpu.pdf#:~:text=Thermoplastic%20polyurethane%20,cooled%2C%20and%20can%20be) [PDF] A guide to thermoplastic polyurethanes (TPU) - Ema Kimya Sistemleri

<https://www.ema.gen.tr/wp-content/uploads/2020/05/TPU-EN-Guide-Tpu.pdf>

[[17]](https://www.alipa.org/wp-content/uploads/2021/03/20190925_19014_ISOPA_ALIPA_PUR_REPORT_REVIEW_FINAL.pdf#:~:text=agents%20or%20flame%20retardants,adhesives%20and%20sealants%2C%20amongst%20others) [[18]](https://www.alipa.org/wp-content/uploads/2021/03/20190925_19014_ISOPA_ALIPA_PUR_REPORT_REVIEW_FINAL.pdf#:~:text=,Polyurethanes%20are%20a) [[19]](https://www.alipa.org/wp-content/uploads/2021/03/20190925_19014_ISOPA_ALIPA_PUR_REPORT_REVIEW_FINAL.pdf#:~:text=thermoplastic%20variants,adhesives%20and%20sealants%2C%20amongst%20others) [[42]](https://www.alipa.org/wp-content/uploads/2021/03/20190925_19014_ISOPA_ALIPA_PUR_REPORT_REVIEW_FINAL.pdf#:~:text=This%20report%20highlights%20the%20key,million%20professionals%20regularly%20rely%20on) [[43]](https://www.alipa.org/wp-content/uploads/2021/03/20190925_19014_ISOPA_ALIPA_PUR_REPORT_REVIEW_FINAL.pdf#:~:text=With%20the%20increasing%20awareness%20of,party) [[44]](https://www.alipa.org/wp-content/uploads/2021/03/20190925_19014_ISOPA_ALIPA_PUR_REPORT_REVIEW_FINAL.pdf#:~:text=What%20are%20polyurethanes%3F%20Polyurethanes%2C%20like,They%20are%20resistant) alipa.org

<https://www.alipa.org/wp-content/uploads/2021/03/20190925_19014_ISOPA_ALIPA_PUR_REPORT_REVIEW_FINAL.pdf>

[[20]](https://europur.org/wp-content/uploads/2021/10/EoL-Brochure-2021-EUROPUR.pdf#:~:text=A%20first%20brochure%20on%20end,broad%20audience%20to%20understand%20the) europur.org

<https://europur.org/wp-content/uploads/2021/10/EoL-Brochure-2021-EUROPUR.pdf>

[[22]](https://highperformanceinsulation.eu/wp-content/uploads/2016/08/Factsheet_15_Life_Cycle_Environmental_and_Economic_analysis_of_polyurethane_insulation_in_low_energy_builidngs__vFebruary2014_-1.pdf#:~:text=1%20PU%20EUROPE%20excellence%20in,social%20performance%2C%20they%20also%20represent) [[23]](https://highperformanceinsulation.eu/wp-content/uploads/2016/08/Factsheet_15_Life_Cycle_Environmental_and_Economic_analysis_of_polyurethane_insulation_in_low_energy_builidngs__vFebruary2014_-1.pdf#:~:text=Environmental%20and%20cost%20performances%20are,The%20dividing) [[24]](https://highperformanceinsulation.eu/wp-content/uploads/2016/08/Factsheet_15_Life_Cycle_Environmental_and_Economic_analysis_of_polyurethane_insulation_in_low_energy_builidngs__vFebruary2014_-1.pdf#:~:text=Table%20of%20contents%3A%201,5) highperformanceinsulation.eu

<https://highperformanceinsulation.eu/wp-content/uploads/2016/08/Factsheet_15_Life_Cycle_Environmental_and_Economic_analysis_of_polyurethane_insulation_in_low_energy_builidngs__vFebruary2014_-1.pdf>

[[28]](https://www.diisocyanates.org/sites/dii/files/visual_select_file/2-handling_mdi_and_tdi.pdf#:~:text=MDI%20and%20TDI%3A%20Safety%2C%20Health,Gilbert%20International%20Ltd%2C%20Manchester%2C%20UK) sou.pdf

<https://www.diisocyanates.org/sites/dii/files/visual_select_file/2-handling_mdi_and_tdi.pdf>

[[29]](https://www.atsdr.cdc.gov/toxprofiles/tp206.pdf#:~:text=The%20ATSDR%20toxicological%20profile%20succinctly,more%20comprehensive%20sources%20of%20specialty) [[30]](https://www.atsdr.cdc.gov/toxprofiles/tp206.pdf#:~:text=The%20principal%20audiences%20for%20the,reviewed%20by%20a) ATSDR TDI and MDI (Toluene Diisocyanate and Methylenediphenyl Diisocyanate) Tox Profile

<https://www.atsdr.cdc.gov/toxprofiles/tp206.pdf>

[[31]](https://www.diisocyanates.org/sites/dii/files/visual_select_file/transportation_handling_march_2019.pdf#:~:text=,ACC%29%20Diisocyanates%20Panel) [PDF] TDI & MDI Safe Transport and Handling Guidelines

<https://www.diisocyanates.org/sites/dii/files/visual_select_file/transportation_handling_march_2019.pdf>

[[33]](https://www.cpsc.gov/s3fs-public/Spray-Polyurethane-Foam-Insulation-Health-and-Safety-Recommendations-for-Consumers.pdf#:~:text=This%20health%20and%20safety%20fact,CPSC%29%20has) [[34]](https://www.cpsc.gov/s3fs-public/Spray-Polyurethane-Foam-Insulation-Health-and-Safety-Recommendations-for-Consumers.pdf#:~:text=Spray%20Polyurethane%20Foam%20,pressure) Spray-Polyurethane-Foam-Insulation-Health-and-Safety-Recommendations-for-Consumers

<https://www.cpsc.gov/s3fs-public/Spray-Polyurethane-Foam-Insulation-Health-and-Safety-Recommendations-for-Consumers.pdf>

[[35]](https://industrial.sherwin-williams.com/content/dam/pcg/sherwin-williams/protective-marine/emeai/common/pdfs/SW%20Brosch%C3%BCre_REACH-Verordnung%203-2023%C2%A9EN-UK-web.pdf#:~:text=then%20completely%20free%20of%20such,EU%20RESTRICTION%20AND%20TRAINING%20REQUIREMENTS) [[36]](https://industrial.sherwin-williams.com/content/dam/pcg/sherwin-williams/protective-marine/emeai/common/pdfs/SW%20Brosch%C3%BCre_REACH-Verordnung%203-2023%C2%A9EN-UK-web.pdf#:~:text=of%C2%A0products%20containing%20more%20than%200,EU%20RESTRICTION%20AND%20TRAINING%20REQUIREMENTS) Safe Handling of Monomeric Diisocyanates

<https://industrial.sherwin-williams.com/content/dam/pcg/sherwin-williams/protective-marine/emeai/common/pdfs/SW%20Brosch%C3%BCre_REACH-Verordnung%203-2023%C2%A9EN-UK-web.pdf>

[[37]](https://www.americanchemistry.com/content/download/6054/file/The-Economic-Benefits-of-the-US-Polyurethanes-Industry-2019.pdf#:~:text=Upstream%20Polyurethane%20Supplier%20Economic%20Impact,8%20Furniture%20and%20Bedding) [[38]](https://www.americanchemistry.com/content/download/6054/file/The-Economic-Benefits-of-the-US-Polyurethanes-Industry-2019.pdf#:~:text=Electronics%20and%20Electrical%20Equipment%20,12%20Conclusion) [[39]](https://www.americanchemistry.com/content/download/6054/file/The-Economic-Benefits-of-the-US-Polyurethanes-Industry-2019.pdf#:~:text=Upstream%20Polyurethane%20Supplier%20Economic%20Impact,9) [[40]](https://www.americanchemistry.com/content/download/6054/file/The-Economic-Benefits-of-the-US-Polyurethanes-Industry-2019.pdf#:~:text=Appendix%201%20%E2%80%93%20Foam%20Product,15) [[41]](https://www.americanchemistry.com/content/download/6054/file/The-Economic-Benefits-of-the-US-Polyurethanes-Industry-2019.pdf#:~:text=Building%20and%20Construction,10%20Appliances) americanchemistry.com

<https://www.americanchemistry.com/content/download/6054/file/The-Economic-Benefits-of-the-US-Polyurethanes-Industry-2019.pdf>

[[45]](https://www.research.ed.ac.uk/en/publications/on-the-use-of-polyurethane-foam-paddings-to-improve-passive-safet#:~:text=On%20the%20use%20of%20polyurethane,953) On the use of polyurethane foam paddings to improve passive safety ...

<https://www.research.ed.ac.uk/en/publications/on-the-use-of-polyurethane-foam-paddings-to-improve-passive-safet>

[[46]](https://pmc.ncbi.nlm.nih.gov/articles/PMC9091468/#:~:text=,Katuscak%20S) Unmodified kraft lignin isolated at room temperature from aqueous ...

<https://pmc.ncbi.nlm.nih.gov/articles/PMC9091468/>

[[47]](https://pubmed.ncbi.nlm.nih.gov/30262722/#:~:text=PubMed%20pubmed,Artur%20Ferreira%20%2C) Polyurethane Foams: Past, Present, and Future - PubMed

<https://pubmed.ncbi.nlm.nih.gov/30262722/>

[[48]](https://www.daryatamin.com/wp-content/uploads/2019/12/Szychers-Handbook-of-Polyurethanes.pdf#:~:text=,Structure%E2%80%93Property%20Relations%20in%20Polyurethanes) [PDF] Szycher's Handbook of Polyurethanes

<https://www.daryatamin.com/wp-content/uploads/2019/12/Szychers-Handbook-of-Polyurethanes.pdf>

[[49]](https://pfa.org/technical-papers/#:~:text=Technical%20Papers%20,based%20polyols%20for%20PU%20foam) [[50]](https://pfa.org/technical-papers/#:~:text=%23%23%20Multifunctional%20Phenol,Chyang%20Lin%2C%20Everlight%20Chemical) Technical Papers - Polyurethane Foam Association

<https://pfa.org/technical-papers/>