
## Rubber. Plastic. Latex.

AKRON RUBBER DEVELOPMENT LABORATORY, INC.

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# A Passion For Problem Solving
## *A Message From Our Founder*

Dear Colleague,

I established Akron Rubber Development Laboratory, Inc. in 1962 because I have a passion for solving rubber problems and I love what I do. I am proud to say that ARDL is now among the leading independent testing and development laboratories for rubber, plastic and latex.

The success and growth of any company is only as good as the people behind it. ARDL currently employs over eighty professional, technical and support personnel that serve our customers all over the world from three modern laboratories in Akron, Ohio.

Today, ARDL's staff meets the varying needs of our individual clients by using in-depth, practical experience in polymers, compounding, testing and consulting.

I invite you to put us to the test.

Sincerely,

Robert Samples
Founder

P.S. Using ARDL will enable you to keep focused on what you do best – running your business. We understand your needs and can solve your technical problems. The ARDL staff and I look forward to building a lasting relationship with you and your company.

# Take A Look At What's Inside

# What Can ARDL Do For You?

Akron Rubber Development Laboratory, Inc. (ARDL) has long been a leading international laboratory dedicated to providing testing, development and problem-solving services to all facets of the rubber and plastic industries. ARDL has the experience, expertise and resources to be your single-source lab, not only for standardized testing, analysis and compound development, but for custom, non-routine services as well. ARDL's diverse technical staff is devoted to building a personal relationship with you in order to better understand the unique challenges you face. This allows you to stay focused on your business while ARDL focuses on finding the solutions to your problems.

If you have the desire to surpass your competition, save money, improve your product, meet specifications or exceed quality control standards, one of ARDL's many services can help you.


# There Are A Lot Of Labs – Why Choose ARDL?

In many ways, ARDL's reputation speaks for itself. Over the past five decades ARDL has worked with more than 12,000 clients to find solutions to more than 100,000 problems. ARDL is focused on finding the answers you need.

Why choose between quality and quantity when you can have both? At ARDL your project will be handled by highly-skilled, experienced professionals and will be completed accurately. ARDL will provide you with results you can actually understand and, best of all, your project will be handled quickly. By housing multiple pieces of equipment, ARDL makes it possible to process numerous projects simultaneously. That leaves you with one thing – faster turnaround time.

ARDL is an independent laboratory and has been ISO certified and A2LA accredited for over twenty years – longer than some other labs have been in business.

Along with a wide range of testing and development services, ARDL also offers a number of products and various consulting services including technical audits, forensic services, patent and research services, plus the guidance to help make your company more efficient and productive.

ISO 9001:2008
Registered

ACCREDITED
*A Testing Lab*
*Certificate Numbers 255.01 & 255.02

# ARDL Is Everywhere...

If it involved polymers, chances are ARDL has been there. The following is a small sampling of the major industries ARDL serves:

| | | |
|---|---|---|
| Aerospace | Automotive | Housewares |
| Industrial | Medical | Military |
| Nanotechnology | Textiles | Transportation |

# Services Available

Using an independent laboratory enables you to stay focused on what you do best – running your business.

### Testing Services

ARDL has an extensive array of equipment and testing capabilities allowing its laboratory to conduct tests on all types of rubber and plastic finished parts, as well as on molded test specimens generated in-house or supplied by you. Specification-compliance-testing capabilities are constantly being expanded to stay in conformance with all industry, government and international standards.

As always, ARDL provides you with the comfort of complete confidentiality, the reliability of quick turnaround time and the proficiency, knowledge and expertise that you deserve and have come to expect.

### Development Services

ARDL provides both product and compound development services. ARDL helps you meet material and performance specifications cost efficiently, giving you a competitive edge.

### Consulting Services

Improving your products and speeding your production processes are important aspects of ARDL's business. Legal consulting, experience-based expert witness and testimony are also offered. Other services include product and factory technical audits, failure analysis, technical training and technical problem solving.

# Chemical Services

ARDL's Chemical Services Laboratory offers a full range of chemical analysis and chemical testing services. ARDL has the resources to truly be a one-stop-shop for all of your testing needs. With years of experience, our chemists, compounders and engineers are prepared to provide you with suggestions on how to solve your toughest problems. From single material identification to complete analysis and theoretical formula reconstruction, ARDL is focused on finding the answers to any problem you are facing.

## ARDL Specializes in the Identification of:

- Chemotherapy/Toxic Chemical Resistance
- Environmental Stress Cracking Failures
- Extractable and Leachable Studies
- Manufacturing Defects
- Process Aids and Flame Retardants
- Product Failures
- Formula Reconstruction/Reverse Engineering of Competitors' Products
- Surface Blooms on Rubbers, Plastics and TPEs
- Unknown Materials, Blends and Contaminants
- UV Degradations
- Waxes, Ester Plasticizers and Oils

## Chemical Services and Equipment Available Include:

- Attenuated Total Reflectance (ATR) and Fourier Transform Infrared Spectroscopy (FTIR)
- C, H, N, S, O Analyzers
- Gas Chromatography/Mass Spectrometry and Pyrolizer-GC/MS
- Inductively Coupled Plasma/Optical Emission Spectroscopy (ICP/OES)
- Karl Fischer Titrator
- Liquid Chromatography/Mass Spectrometry (LC/MS$^{(4)}$)
- Permeability/Permeation (Gas/Liquid)
- Thermal Analytical Testing (DSC, TMA, DMA, TGA)
- Thin Layer Chromatography (TLC)
- Ultraviolet/Visible Spectroscopy (UV/VIS)

# Dynamic Testing

Dynamic testing is performed on a vast array of rubber articles including belts, biomedical components, bridge bearing pads, dynamic seals, engine mounts, exhaust hangers, shock mounts, tires, vibration isolators, etc., to determine their response to cyclic stress/dynamic load.

ARDL has seven servohydraulic load frames along with two Metrovib electrodynamic testing machines that are capable of dynamic characterization of elastomeric parts as well as stroke and load control fatigue testing.

## MTS 831.20 Elastomer Test System

### Specifications:

- Frequency Range: 0.01 Hz to 400 Hz
- Displacement Range: ± 1⅜ in.
- Load Range: ± 5,500 lbs
- MTS LX500 Laser Extensometer
- Temperature Cycling Chamber: -100°C to +315°C

### Resonant Search:

- Determines the Resonant Frequency of Rubber Components

### Static Deflection:

- Determines the Static Spring Rate of Rubber Components

### Measurement Options:

- Dynamic Characterization
- Determines the Material Properties of Rubber: K*, K', K", Tan Δ, E*, E', E", C
- Frequency and Strain Sweeps
- Total Energy
- Sample Geometry
  - Dual-Lap Shear
  - Quad-Lap Shear
  - Hollow Cylinder
  - Solid Box
  - Product/Parts
  - Solid Cylinder

## Metravib – DMA +150 – Electrodynamic Testing Machine

The Metravib Electrodynamic Testing Machine has the ability to generate quantitative dynamic property data for modelers and end-users and can duplicate the shear field experienced at the edge of steel belt radial tires. ARDL can test to ASTM D 5992, ASTM D 5026, ISO 6721 and unique customer specifications.

### Major Capabilities:

- Dynamic Property Measurements: E*, E', E", Loss Angle, Tan Δ, G*, G', G", J*, J', J", Energy Recovered & Energy Dissipated
- Temperature Sweeps (-150°C to +450°C)
- Frequency Sweeps
- Strain Sweeps
- Creep
- Fatigue
- WLF Master Curves

### DMA:

- Kinetic Tests
- Stabilized Temperature Tests
- Temperature Ramp Tests
- Specific Analysis
- Thermo-Mechanical Analysis (TMA)
- Transient Analysis

### Deformation (Excitation) Modes:

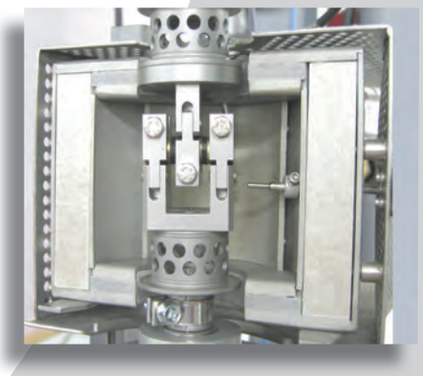
- Tension
- Compression
- Simple Shear
- Annular Pumping, Annular Shear, 3-Point Bending, Dual and Single Cantilever Bending

### Specifications:

- Frequency Range: 0.001 Hz to 1,000 Hz
- Force Range: ± 150N
- Displacement Range: ± 6 mm

### Applications:

- Rubber, Plastic, Film and Fiber



## MTS 312.21 Dynamic Test Unit

The MTS 312.21 Dynamic Test Unit is a hydraulically actuated load frame with load tension and compression capabilities and has static/dynamic programmable cycles. This unit has the stroke capability for special and larger designs.

### Capabilities:

- Fatigue Testing
- Creep
- Durability Testing
- Specific/Custom Engineering Testing
- Temperature Cycling Chamber
- Whole Tire Analysis (Static Spring Rate, Whole Tire Hysteresis, Tire Dynamic Mechanical Properties)

### Applications:

- Engine Mounts
- Bridge Bearing Pads
- Shock and Vibration Isolators
- Rail Pads
- Special and Larger Design Applications

# Engineering Services

ARDL's Engineering Group welcomes your most demanding engineering challenges and offers technical support for many materials including rubbers, plastics, composites and adhesives. Not only can ARDL test to standard specifications, we also build nonstandard test apparatus customized for your unique requirements. Specializing in test development, design, manufacturing, execution and results interpretation, ARDL provides you with the most complete and thorough simulated in-service analysis available.




## Engineering Services Available Include:

- Component Testing
- Compression Stress Relaxation
- Dynamic Testing (Mechanical, Servo-Hydraulic and Electro-Dynamic)
- Electrical Testing
- FEA Support Testing
- Finite Element Analysis (FEA) and Modeling
- High Pressure/High Temperature Testing
- High Strain Rate Testing
- Life Prediction for Rubber Parts
- Mini-DeMattia Testing
- Modulus Profiling
- Proton NMR
- Rapid Gas Decompression Testing (RGD) for Oil and Gas Drilling Materials
- Reverse Engineering

# Forensic Services

Rubber products sometimes fail before they wear out. If failure leads to property damage or personal injury, regardless of the cause of failure, manufacturers can find themselves involved in litigation (claims and lawsuits) in the United States, even when there is no problem with their product.

## Courtroom Demonstrations

Courtroom demonstrative aids are helpful in presenting and explaining failure modes and conditions to jurors. ARDL is skilled in fabricating demonstrative aids and presentations. Your lawyer will understand the importance of this expertise.

## Destructive Testing

When destructive testing is required and is authorized by the court, ARDL can dissect molded rubber goods, test materials removed from the products or facsimiles and examine exposed surfaces with light optical microscopy, scanning electron microscopy or transmission electron microscopy, as appropriate. ARDL runs extensive chemical as well as physical tests on products and components as required. ARDL also has a 6-station roadwheel for research and development studies or experimentation on tires.

## Non-Destructive Testing

ARDL's laboratory is well equipped to perform non-destructive and destructive testing on tires and composite materials. Non-destructive testing often requires Shearography, Visual and Microscopic analysis and documentation utilizing digital photography.

## At ARDL, The World's Leading Forensic Services For Rubber Failure Analysis Are Maintained, Including:

| | |
|---|---|
| Failure Mode and Effect Analysis | Rubber Product Failure Analysis |
| Intellectual Property Issues | Steelcord Adhesion Studies |
| Materials Analysis | X-ray Analysis |
| Optical and Electron Microscopy | |

# Medical Device Testing and Development Services

ARDL has a proven, quality-based medical device development process, and intellectual property developed for a client always becomes the property of the client. ARDL can assist you with test protocol design, mechanical fixturing, data gathering, in-depth analysis and the interpretation of your results.

## Testing and Development Experience Includes:

| | |
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| Balloons | Heart Valve Components |
| Catheters (Catheter Compliance Measuring per AAMI & ISO Standards) | Orthopedic Implant Testing<br>• Multiaxis Testing for Advanced Wear and Kinematic Studies<br>• Materials Characterization per ASTM, AAMI and ISO Standards<br>• Custom Fixture Design and Test Protocol Development<br>• Ultimate Strength and Attachment/ Detachment Measurements |
| Condoms | |
| Cups | |
| Diaphragms | |
| Drug Sundries | |
| Engineered Tissue | |
| Flexural Bend Testing for Finger, Toe, Spine, Jaw and Other Implants | Stents |
| Graft Devices | Stoppers |
| Gloves (Chemical, Electrical, Examination, Industrial, Surgical, etc.) | Spinal Disks |
| | And Many Other Medical Goods |

## Product Development

ARDL's approach will rapidly transform your product concepts into reality. Our three-phase process has resulted in the successful commercialization of medical products for some of the largest medical device manufacturers in the world. Project managers at ARDL work closely with clients to develop project schedules that include well-defined tasks and milestones for each phase of development.

### Phase 1

**Product Definition**

- Quality Plan Review
- Product Functionality
- Product Material Specification
- Initial Risk Analysis

### Phase 2

**Product Development**

- Concept Development
- Preliminary Product Review
- Detailed Geometry Review
- Critical Geometry Review

### Phase 3

**Implementation**

- Test Plan
- Prototype Building
- Product Testing
- Quality Plan Review

## Product Failure Analysis

Failure Analysis of medical products requires the use of unique mechanical and analytical techniques. The final goal of a product failure analysis is the determination of the mode and cause of failure. The first step is to perform a thorough inspection of the failed part, initially with an optical stereomicroscope and subsequently with a scanning electron microscope. Mechanical testing provides the tensile, dynamic, impact, thermal and stiffness properties of the material(s). While procedures vary, the primary mechanical tests provide a comparison of measured data to a specification or to data generated by a known benchmark. Computer-aided stress analysis can provide the stress distribution of the part in service with the results detailing the geometrical effect of the failure.

# Microscopy Services

Standard light microscopy, along with both transmission and scanning electron microscopy, support the characterization and failure analysis capabilities of ARDL. These techniques can be used along with X-ray analysis to determine the structure and homogeneity of blends, presence of impurities, type of carbon black and inorganic additives used.

## Microscopy Services Available Include:

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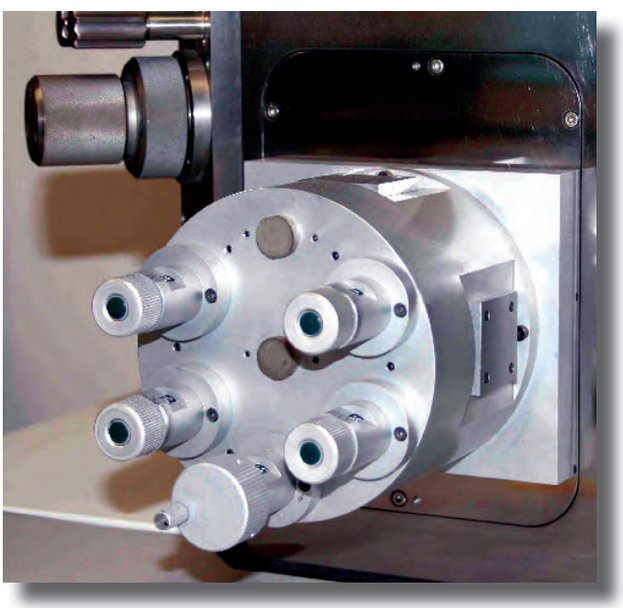
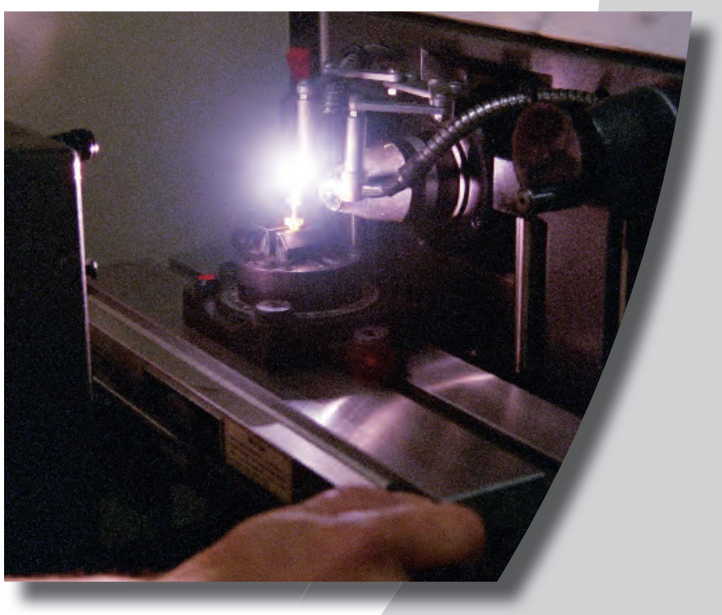
| Carbon Black Testing / Carbon Black Typing (TEM) |
| Coating and Film Thickness (LOM / OC / SEM / EDX / TEM) |
| Dimensional Analysis (LOM / OC) |
| Dispersion Analysis (LOM) |
| Elemental Analysis and Multi-Element Dot Mapping (EDX) |
| Failure Analysis (LOM / SEM / EDX / TEM) |
| Foam Cell Size (LOM) |
| Internal Structure Features (LOM / SEM / TEM) |
| Metal-to-Rubber Bonding (SEM / EDX) |
| Micro-Dispersion Analysis (SEM / EDX / TEM) |
| Particle Size and Particle Size Distribution (LOM / SEM / TEM) |
| Polymer Blend Morphology (LOM / TEM) |
| Room Temperature and Cryogenic Microtoming (LOM / TEM) |
| Surface Analysis (LOM / SEM) |





* EDX is Energy Dispersive X-ray, LOM is Light Optical Microscopy, OC is Optical Comparator, SEM is Scanning Electron Microscopy, TEM is Transmission Electron Microscopy

# Mixing & Compounding Services

ARDL's compound development services can help you reduce costs, develop new products, improve quality and reliability, problem solve, meet specifications and promote quality control.

From highly technical developments, to simply adapting one of the more than 5,000 compounds in our recipe library, ARDL's knowledgeable staff can provide you with cost efficient and effective formulations that meet your distinct objectives.

## Mixing & Compounding Services Available Include:

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|---|---|
| Calendering | Problem Solving |
| Compound and Process Development | Processability Testing<br>*Extrudability*<br>*Mooney Viscosity*<br>*Mooney Scorch*<br>*Rheometer*<br>*Vulcanization* |
| Compounding and Mixing (Instrumented Banbury) | |
| Curing | |
| Evaluative Testing | |
| Mold Prototyping | |
| Molding | And More! |

# Pharmaceutical & Microbiological Services

ARDL is able to perform a number of USP testing procedures per cGMP guidelines to certify that your products are of the appropriate quality, integrity, consistency and potency. Our pharmaceutical services can assist you in meeting USP <381> Elastomeric Closures for Injections and USP <661>: Containers - Plastics standards. ARDL is FDA Registered and is the independent laboratory many closure and container manufacturing companies contact to ensure they meet the high standards of the USP and the FDA.

Our laboratory also specializes in extractable/leachable studies of various medical devices as required for 510(K) applications, material selection or simply problem solving needs. ARDL is one of the few contract labs in the world applying these types of studies to medical devices handling chemotherapy drugs.

ARDL's Microbiological Services laboratory focuses on latex protein testing and biocompatibility assays and further expands ARDL's capabilities in the microbiological fi eld. These capabilities include test methods for analysis of aqueous extractable protein in natural rubber and natural rubber products using ASTM D 5712 and also the immunological measurement of antigenic protein using ASTM D 6499.

## Pharmaceutical & Microbiological Testing Services Available Include:

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| **cGMP Laboratory US Pharmacopeia Testing** |
| - USP <661>: Containers - Plastics |
| - USP <381>: Elastomeric Closures for Injections |
| |
| **Microbiological Services Laboratory** |
| - ASTM D 5712 - Standard Test Method for Analysis of Aqueous Extractable Protein in Natural Rubber and its Products Using the Modified Lowry Method |
| - ASTM D 6499 - Standard Test Method for the Immunological Measurement of Antigenic Protein in Natural Rubber and its Products |

# Physical/Mechanical Testing

Physical testing is essential to measuring the quality and regulatory compliance of your company's products. ARDL offers a wide range of physical testing services to evaluate and certify your materials or components. Physical testing can be performed on a variety of plastic materials and textiles, as well as on rubber.

ARDL has the expertise and resources to perform custom, non-routine services along with testing to universal specifications. ARDL's experienced technicians are trained to advise you on how to solve your problems in a way that you can understand, so you can be 100% confident your materials will perform at their best.

## Physical Testing Available Includes:

- Abrasion
- Adhesion
- Aging, Degradation and Fatigue Testing
- Basic Physical Testing: Compression Set, Hardness, Tensile, Tear, etc.
- Burst Testing
- Coefficient of Friction
- Color Testing (Datacolor SF600 Spectrophotometer)
- Electrical Testing
- Flexible Cellular Material Testing (Sponge and Foam)
- Glove/Condom/FDA Testing
- Low-Temperature Testing
- Plastic Specific Testing
- Rebound Testing
- Smoke and Flame Testing
- Weathering

# Plastic Specifi c Testing

ARDL has a fully equipped plastics and thermoplastic elastomer testing laboratory. Testing services include physical testing such as compressive properties, environmental stress cracking, impact testing, flexural modulus, fog characteristics, Rockwell hardness, tear properties and tensile properties. Chemical testing capabilities include DSC, polymer identifi cation, extractable/leachable testing, permeability, HPLC and reverse engineering of the polymer structure. Measurement of a material's sensitivity to impact and also its resistance to impact from a swing pendulum are regularly performed as well.

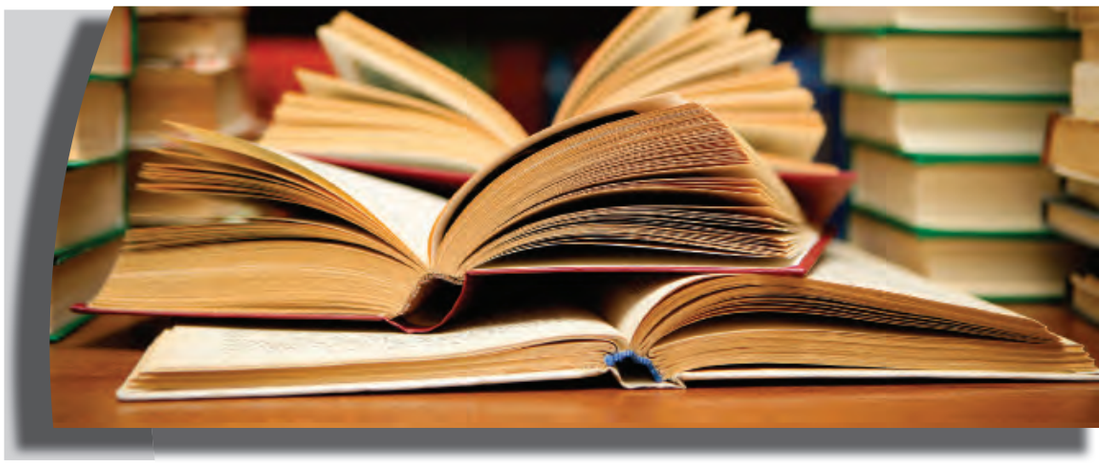
ARDL's plastics testing laboratory is capable of injection molding rigid plastic and TPE materials into test specimens. Capabilities for melt flow rate measurement, injection mold shrinkage, heat deflection and the grinding of plastic and TPE materials into pellets for easier processing are also available.

## Plastic and Thermoplastic Elastomer Testing Services Available Include:

| |
|---|
| Compressive Properties of Rigid Plastics |
| Environmental Stress Cracking |
| Flexural Modulus |
| Fog Characteristics |
| Grinding of Plastic and TPE Materials |
| Heat Deflection Temperature |
| Instrumented Impact |
| Izod & Charpy Impact Testing |
| Injection Molding of Plastic and TPE Materials |
| Injection Mold Shrinkage |
| Melt Flow Rate |
| Physical Properties |
| Rockwell Hardness |
| Vicat Softening Point |

# Research & Development

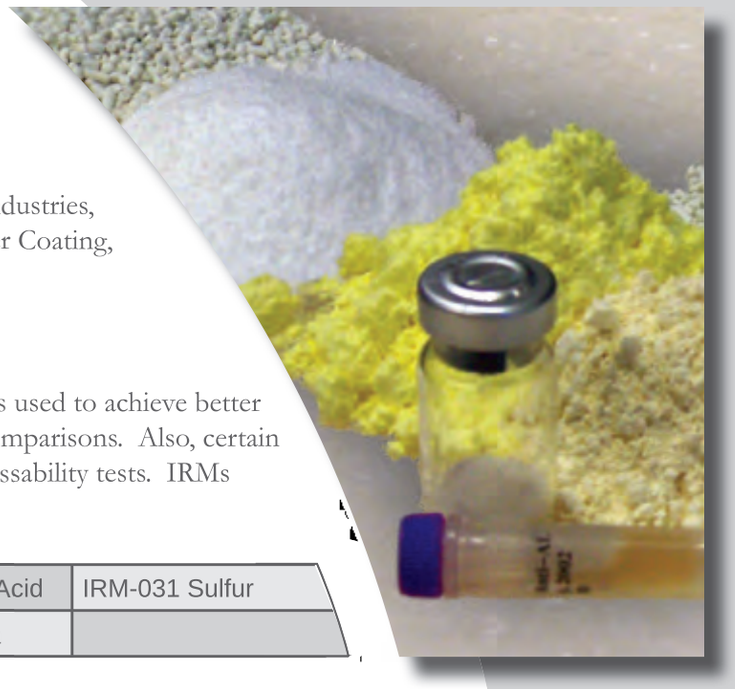
ARDL offers complete problem-solving services. Whether you are developing a new product or improving an existing one, ARDL has the experience, expertise and resources to facilitate your needs. Utilizing its vast library along with services from each department within its laboratory, ARDL can do everything from your groundwork research to the development necessary to take your final product to market. ARDL can even develop customized testing apparatus and procedures to suit your unique needs.



## ARDL Can Find Whatever It Is You're Looking For...

- Comparative Research on Materials, Methods and Products
- Compound Research and Development
- Government Bids and Opportunity Notifications
- Literature/Document Searching
- Materials Research
- Patent Searching
- Product Information
- Specification Research and Development

# Products Available



ARDL offers a number of products to aid the rubber and plastic industries, including Industry Reference Materials (IRMs), PolyData™ Polymer Coating, Rheometer Control Compound (SBR) and Test Plaques.

## Industry Reference Materials

Industry Reference Materials are standard compounding ingredients used to achieve better agreement with standard ASTM recipes and inter-laboratory test comparisons. Also, certain IRMs are used to compare inter-laboratory results for rubber processability tests. IRMs currently available at ARDL include:

| | | | |
|---|---|---|---|
| IRM-002 MBTS | IRM-003 TBBS | IRM-021 Stearic Acid | IRM-031 Sulfur |
| IRM-241 Butyl | IRM-913 NR Protein | IRM-914 Antisera | |

## PolyData™ Polymer Coating

PolyData™ Polymer Coating is a top-coating, liquid printing primer for computer-imprintable plastic-film and stock labels. This coating allows plastic-film labels to accept standard, computer-generated printing and permits the end user to finish printing the rest of the label on a personal computer. This can increase profit margins for manufacturers of labels by providing very durable, multi-tasking, on-demand labels.

## Rheometer Control Compound (SBR)

Statistical process control is fundamental for success in today's high-precision, high-volume rubber and plastic industries. Instrument calibration to standard references with continuous monitoring is the key to statistical process control. Without it, keeping your production on-line and on-spec is nearly impossible.

ARDL is the source for your lab's vital control material: a standard compound for Rheometer process control. This product, a certified SBR compound chosen for its reproducibility, is produced by ARDL under carefully controlled and monitored conditions. This reference material is available with certified characteristics.

## Test Plaques

Members of the oil and grease industries need control reference rubber compounds to evaluate the effects of changes in oil/grease composition or in additive packages on rubber.

ARDL is your approved source for these vital control compounds. The following AMS Materials and Rubber Test Plaques (6″ x 6″ x 0.075″ cured rubber sheets) are available:

| | |
|---|---|
| AMS 3217/1B *Acrylonitrile Butadiene (NBR-H)* | AMS 3217/2B *Acrylonitrile Butadiene (NBR-L)* |
| AMS 3217/3B *Neoprene (CR)* | AMS 3217/4A *Viton (FKM)* |
| AMS 3217/5B *Fluorosilicone (FVMQ)* | SAE J2643 (*ACM, AEM, ECO, FKM, FEPM, FVMQ, HNBR, NBR-1, NBR-2, VMQ)* |
| Ford Mercon ATTR *(ACM, AEM, CSM, FKM, HNBR, NBR-1, VMQ)* | |

# Working With ARDL

Whether you're a mile down the road or halfway around the globe, outsourcing to ARDL is easy. When you discover a problem or have a need for testing, contact ARDL via phone, fax, web or email. The appropriate department will respond to your inquiry and assist you with any questions.

After receiving your quotation, go to www.ardl.com and print a Sample Submittal Form, fill it out and simply send it in with your samples, your Purchase Order and a copy of the specification you would like your samples tested to (if necessary). Samples can also be dropped off in person, Monday through Friday from 8am - 5pm.

Once your samples are received, they are logged in, given a project number (PN) and a manager reviews your request. Your project is then completed by ARDL's technicians and a test report is issued via electronic mail. Reports can also be faxed or mailed.

## Get Started Now!

To request a quotation, email **answers@ardl.com** or call us toll free at (866) 788-ARDL or worldwide at (330) 794-6600. You can also learn more about what ARDL has to offer and request a quotation online at: **www.ardl.com**