

Case Study | Zeus Industrial Products, Inc.

# How Zeus Used PEEKshrink™ to Solve an Insulation Problem

Zeus PEEKshrink™ **heat shrinkable tubing**  
enabling smart drilling technology for  
natural gas and oil exploration.



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# ZEUS®

Smart Technology PEEKshrink for Energy Exploration



## BRIEF

*Oil and gas engineers needed a material to protect sensitive wiring from extreme temperatures, pressures, and dielectric interference during deep-well oil drilling.*

After testing other materials, Zeus PEEK heat-shrinkable tubing, known as PEEKshrink™, was selected to form a “second skin” around the wires thus ensuring data transmission in harsh environments.

### THE APPLICATION

Oil companies are under pressure to find new sources of oil. These untapped resources are found in increasingly challenging environments. Reliability of technology has a direct impact on drilling performance and overall project cost.

## NOTABLE BARRIERS

- Temperature
- Pressure
- Dielectric Interference



## CHALLENGE

*Oil and gas research companies needed a reliable alternative material to protect sensitive wiring at the drill end of the pipe.*

Since 1997, oil and gas researchers have been working to develop an intelligent drill-string system for the high-speed, bi-directional transmission of real-time data to assist in identifying previously undiscovered pockets of oil in existing wells. Funded in part by the U.S. Department of Energy, this new intelligent technology network replaces mud-pulse telemetry - a slow, unreliable technology currently used in down-hole exploration.

In early 2000, researchers found themselves in a quandary. The materials they had been using to protect the wiring in a data transmission antenna would fail under the harsh drilling conditions. For the new network to work, they needed an alternative material to protect sensitive wiring at the drill end of the pipe.

## ROADBLOCKS

- Dwindling Resources
- Hazardous Environment
- Stronger Material Need



## SOLUTION

*The Zeus team delivered a total solution that has enabled oil and gas researchers to make dramatic progress toward commercial success.*

Zeus Industrial Products, Inc., a world leader in the design and production of high performance fluoropolymer extrusions, provided the solution: PEEKshrink™ - a heat shrinkable PEEK tubing. Since the 1980s, Zeus has been extruding PEEK polymer supplied by Victrex in a range of commercially successful formats for medical, electrical, fluid handling, and mechanical applications. Our PEEK extrusions are renowned for their precise and tenacious performance in extreme applications. Delivering tensile, mechanical, and dielectric strength; hydrolytic stability in hot water, steam, solvents, and chemicals; and resistance to stress cracking and bursting define PEEK polymers. Our PEEKshrink™ tubing delivered these properties to the new intelligent network application. The Zeus team delivered a total solution that has enabled oil and gas researchers to make dramatic progress toward commercial success.

### SOLUTION BENEFITS

- Product Life Extension
- Shrink Range 575-725°F
- Consistent 1.4:1 Ratios



## THE STORY

*“Smart drilling” is the modern approach to oil exploration that allows oil companies to drill safer to more productive wells by using down-hole communication systems.*

These systems, which employ various types of sensors and telemetry units, transmit data from downhole tools to the surface as the well is drilled. This includes information like temperature, geology, pressure, and rate of penetration used by those on the surface to make decisions on where to drill, when to stop, and when to proceed.

Oil companies have relied on mud-pulse telemetry as the industry standard for data transmission from the drill site to the surface. The technology is slow - it typically functions at three to twelve bits per second - and has limited capability to receive commands from the surface. While serviceable, it does not deliver the speed and accuracy demanded by oil explorers.

With partial funding from the U.S. Department of Energy, a Provo, Utah-based engineering group has spent several years developing an intelligent drill-string system for the high-speed, bi-directional transmission of real-time data. The technology is light years ahead of mud-pulse telemetry, transmitting data to and from the surface to the drill head at rates of up to one million bits per second. This intelligent technology, which was subsequently acquired by a leading drill pipe technology company, enables drilling operators to instantaneously and more precisely direct the drill bit toward pockets of oil and away from dead ends.

Key to the intelligent drilling network is the high-speed data cable inside of a high-pressure conduit. Ensuring the integrity of key wiring used inside each joint of pipe and preserving its ability to transmit in a robust fashion under extreme conditions posed a significant challenge for project engineers. The proprietary wire had to be protected from extreme heat, pressure, friction, salt water, and steam. However, the wire had to be protected from electrical interference that might compromise its data transmission capability.





Project engineers knew the material selected to protect the wire had to provide lap shear bond strength because any type of separation between the wire and the coating would result in a costly failure. The first material tested was spray-coated PTFE polymer. Pressure from water and steam caused the coating to flake off. Kapton<sup>®</sup> polyimide dispersion coating was tested next. Though proven to perform in electrical applications for more than 30 years and recognized for its stability at elevated temperatures, the \*Kapton<sup>®</sup> coating also failed.

Representatives of Victrex, a leading producer of PEEK polymer, suggested the project engineers working on the intelligent network contact Zeus, a leading producer of high performance, precision PEEK tubing. Zeus' success with PEEK across a wide range of challenging applications was well known to Victrex, and the project appeared well suited to Zeus' problem-solving abilities.

Zeus R & D scientists and polymer engineers recommended PEEKshrink<sup>™</sup> heat shrinkable tubing. PEEK is widely regarded as one of the highest performance thermoplastic materials. What sets PEEK apart from other polymers is its ability to retain its mechanical properties at extremely high temperatures (*continuous service temperature of 500 °F / 260 °C*). PEEK is also exceptionally strong and highly resistant to organic and inorganic solvents.





Smart Technology PEEKshrink for Energy Exploration



With wire samples from the customer, Zeus' R & D department set about testing their PEEKshrink™. Zeus' objective was to create a homogeneous bond between the wire and the PEEKshrink™, recognizing that the tighter the bond, the less likelihood of failure. The scientists determined that by changing the morphology of the PEEK and altering the structure of the polymer crystals, the heat-shrinkable PEEK delivered the required lap shear bond strength, forming an impenetrable shield around the wire. The project engineers had their coating.

Material selection was just one aspect of Zeus' total solution. A technical team traveled to meet the network project engineers to assist with the set-up of the processing operation and to ensure optimal processing rates. When the engineers began experiencing unacceptably high scrap rates, Zeus' troubleshooting uncovered the problem. Cleaning the wire prior to processing improved quality and reduced scrap.

In its first commercial test, about 6,400 feet of the new intelligent network telemetry drill pipe was used in an Oklahoma well for 500 drilling hours. A high-speed data link was successfully established with above-ground receivers, putting the intelligent network developer's tubular products on the fast track for commercialization.

Zeus is ready to assist with any volume requirements of their PEEKshrink™ heat shrinkable tubing. With production plants or offices in the United States, Europe, and China, Zeus has the capacity and the capabilities to supply this high-performance tubing anywhere in the world.





## AT A GLANCE

*Zeus provided a proven component in its PEEKshrink™, they provided research and development, manufacturing, and troubleshooting support at critical junctures.*

- The intelligent network developer required a material that would deliver superior lap shear bond strength ensuring the network's ability to transmit data from deep inside the earth. Zeus' PEEKshrink™ heat shrinkable tubing provided an impenetrable "second skin" around key wiring, locking out contaminants and securing the integrity of the cable.
- The network developer tried two materials prior to selecting Zeus' PEEKshrink™ tubing: a spray-coated layer of PTFE polymer, which flaked off due to the extreme pressure of water and steam, and a Kapton® polyimide dispersion coating that also succumbed to pressure under testing.
- PEEK is widely regarded as one of the highest performing thermoplastics. Zeus' experience with PEEK in terms of material modification, extrusion, optimization, and applications enabled Zeus to provide a new PEEK heat shrinkable product that formed a homogenous bond around the intelligent network wiring, making them impervious to temperature extremes, steam, salt water, and electrical interference.
- Zeus took a total solution approach to the oil and gas intelligent network project. Not only did Zeus provide a proven component in its PEEKshrink™, they provided research and development, manufacturing, and troubleshooting support at critical junctures. As this network increases in its commercial activity, Zeus is prepared to handle volume orders with multiple facilities on campuses in the United States, Europe, and China.



## AT A GLANCE

*We thrive on difficult applications that lead to scientific and commercially viable breakthroughs.*

*"We thrive on difficult applications. It's not the polymer that solves the problem; it's what Zeus does to enhance the innate performance attributes of a polymer so it aligns with a specific application that leads to scientific, commercially viable breakthroughs."*

*- Robert Ballard,  
Vice President of Research and Strategic  
Business Development Zeus, Inc.*

*"During testing, it became very clear that we would be hard pressed to find another polymer or material construction to compete with Zeus' PEEK heat-shrinkable tubing in this application."*

*- Scott Dahlgren,  
Sr. Development Engineer  
for the intelligent network*

### PEEKshrink™ Advantage

- High continuous operating temperature 752 °F (400 °C) for NEMA MW 1000
- Extends life of the protected item
- Assures reliable performance
- Shrink temperature 650 °F – 725 °F (343 °C – 385 °C)
- Consistent shrink ratios of up to 1.2:1 and above
- 10-20% longitudinal shrinkage

\*Kapton® is a registered trademark of E.I. du Pont de Nemours and Company.

# Get to know Zeus.



**2,400+**  
TEAM MEMBERS



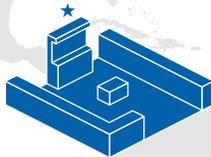
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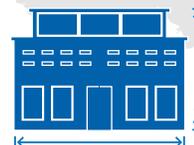
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## — OUR MISSION —

PROVIDE SOLUTIONS · ENABLE INNOVATION · ENHANCE LIVES

Zeus, headquartered in Orangeburg, South Carolina, is the world's leading polymer extrusion and catheter design manufacturer. With over 55 years of experience in medical, aerospace, energy, automotive, fiber optics, and other leading industries, Zeus's mission is to provide solutions, enable innovation, and enhance lives. The company employs over 2,400 people worldwide with facilities in Aiken, Columbia, Gaston, Orangeburg, and St. Matthews, South Carolina; Branchburg, New Jersey; Chattanooga, Tennessee; San Jose, California; Arden Hills, Minnesota; Guangzhou, China; and Letterkenny, Ireland. For more information, visit [www.zeusinc.com](http://www.zeusinc.com).



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