

Materials Tech/ Vehicle Lightweight

JOHN DAVIS: From the days before Henry Ford's Tin Lizzie, mass market cars have been made primarily of steel. It is relatively cheap, strong, durable and easy to work with. But it's also heavy. If we all could afford Bugattis, then carbon fiber would be an easy answer. It's half the weight of steel and four times stronger. But at \$15 per pound, it's more than three times the cost.

Aluminum is another light, but more expensive, alternative to steel. And upscale brands like Audi, Jaguar and Land Rover have pioneered its use in the mass market.

But now Ford is jumping on the aluminum bandwagon with its highest volume vehicle, the F150. The 2015 model pickup will tip the scale some 700 pounds lighter than before thanks to an all-aluminum body and bed.

Like a diet for humans, there is no one size fits all solution to vehicle light-weighting. But at the Department of Energy's Oak Ridge National Lab near Knoxville, Tennessee, auto makers, suppliers and DOE researchers are co-developing the next generation of advanced materials and lightweight automotive components.

This electric arc furnace allows the operator to melt small quantities of different metals together to create entirely new alloy compositions for study. Nearby the 1,000 degree Celsius furnace and roller mill test the workability of the new metals as they are made into thinner sheets.

Along with the development of new metal compounds comes the need to join them together. Here, researchers are demonstrating a low-temperature friction stir welder that could be used instead of rivets to join aluminum and steel together.

Quality checking spot welds has always been a productivity killer on assembly lines. This automated, infrared weld inspector can detect the heat signature of each weld as it is performed and determine if it's good or bad. And then compensate with extra welds or adjust the welder settings on the fly.

Seventy years ago, scientists here were studying how to harness the energy in Plutonium. But Oak Ridge is better known these days for studying the atomic structure of materials with the high-flux isotope reactor, its dense neutron beam pad to split among thirteen specialized instruments used to validate the molecular and magnetic structure of various materials.

MIKE SIMONSON: This machine is designed to look inside alloys and parts that have actually been manufactured by various processes to understand at the atomic level what the strains and stresses are within the material.

JOHN DAVIS: Using ordinary acrylic fiber, like that used to make socks or sweaters, the team at Oak Ridge's carbon fiber facility has created a carbon filament with much of the same properties as the pure material but at a third of the cost. Winding repeatedly through four ovens, the white fiber is oxidized; then a blast in the 1,000 degree furnace vaporizes everything but the carbon.

Nothing is cooler than seeing a part materialize before your eyes. And that's what additive or 3-D printing is all about. Here Oak Ridge scientists have used a plastic and carbon fiber composite to print large custom parts and even an entire go-cart chassis. More impressive, though, is the ability to create a complex moving gear and track assembly or a functioning mechanical hand in one build out of titanium.

The down-sizing of existing components is crucial for weight-savings too. Oak Ridge researchers have re-configured an electric car power inverter to nearly half its former size and are developing new battery electrode materials that allow more energy stored per volume. So an EV could increase its driving range or shrink its battery size to save weight.

Now, we may not be 3-D printing our own cars at home any time soon, but with these advances in automotive materials engineering, Oak Ridge and the other DOE national laboratories are pointing us in the right “light” direction.