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TechNotes

Getting the most up-to-date information on materials testing

In This Issue

Liquidmetal – Not Just for Terminators

Dr. Jan Shroers with metal bottle

Photo courtesy of Dr. Shroers

Materials scientists have been trying for years to discover and develop a product that could be molded into complex shapes with the ease and low expense of plastic while retaining the strength and durability of metal. Recently, a team led by Dr. Jan Schroers, a materials scientist at Yale University, has recently developed some metal alloys that can be blow molded like plastics into complex shapes that can't be achieved using regular metal, without sacrificing the strength or durability that metal affords.

Liquidmetal is a commercial name for a series of bulk metallic glass (BMG) alloys developed by a CalTech research team and marketed by a firm called Liquidmetal® Technologies. BMG alloys are solid at room temperature, but they become increasingly soft and liquescent at higher temperatures rather than exhibiting a fixed melting point as with a conventional metal.

It's the atomic structure of a BMG alloy that differentiates it from a conventional metal. The atomic structure of a conventional metal is crystalline, with repeating crystal patterns in planes, and usually containing dislocations, or irregularities, in the structure. The tendency of the crystalline structure to slip and deform under load limits the overall mechanical performance of conventional metals.

The atomic structure of BMG alloys is amorphous, where no discernable patterns exist in the atomic structure. The absence of grain boundaries and dislocations results in a material with a large elastic strain limit and a very high yield strength, close to the theoretical limit. As an example, one zirconium-based BMG alloy exhibits a yield strength of up to 2 GPa and an elastic strain limit of about 2%. BMG alloys also demonstrate excellent corrosion resistance, very high hardness, and excellent anti-wearing characteristics, while also being able to be heat-formed in processes similar to those used with thermoplastics.

Liquidmetal was introduced commercially in 2003 and has been used to manufacture electronic casings, medical devices, jewelry materials, and sporting goods. Die-casting is the main manufacturing process, but it is subject to conflicting demands. The conditions needed to obtain high-quality casts are slow cooling and small temperature gradients. In a die-cast process, the liquid BMG must fill the entire mold cavity while at the same time be cooled fast enough to avoid crystallization. This makes casting of parts with complex geometries difficult.

Recently, a team led by Dr. Jan Schroers, a materials scientist at Yale University and the former Director of Research at Liquidmetal Technologies, has shown that some newly developed BMGs can be blow molded like plastics into complex shapes. Schroers claims that the alloys can be blow molded just as cheaply and as easily as plastic. So far his team has created several complex shapes, such as metallic bottles, watch cases, miniature resonators, and biomedical implants, that are seamless, twice as strong as steel, and can be molded in less than a minute.

On the tech blog Cult of Mac, Schroers said it is likely Apple, who has been interested in the possibilities afforded by BMGs for some time, will invest heavily in commercializing the technology. Apple has a long history of pioneering cutting-edge manufacturing techniques, and its long-standing interest in design makes it likely to explore the material's capabilities.

Sources

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"Thermoplastic blow molding of metals", *Materials Today*, Jan-Feb 2011, Volume 14, Number 1-2, Jan Schroers, Thomas M. Hodge, Golden Kumar, Hari Raman, Anthony J. Barne, Quoc Pham, and Theodore A. Waniuk.
Yale University. "Stronger than steel, novel metals are as moldable as plastic." *ScienceDaily*, 8 Feb, 2011. Web.
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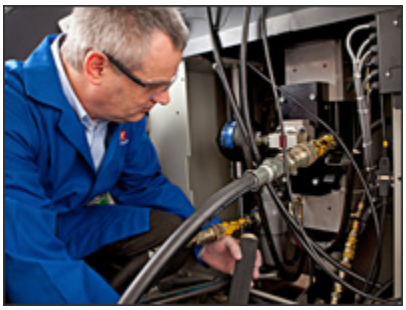
When did you last change your oil?



It's no secret that hydraulic fluid contamination leads to increased wear and corrosion, and decreased fluid life and system performance. At the same time, you want to maximize the life of your oil to reduce costs and downtime. It's a balancing act.

Here are some tips for getting the most out of your hydraulic fluid:

- Don't skimp on quality. Use a good quality hydraulic fluid from a reputable manufacturer following the specification recommendations from the pump and system manufacturer.
- Keep hydraulic fluid clean, cool, and dry. Maintain filtration, and use clean lines to transfer hydraulic fluids into your equipment.
- Proactively analyze both your used fluid and your in-service fluid for contamination, oxidation, and to assess wear on the system.

Increasing the frequency of fluid changes may prove to be particularly cost effective in the long term. Research by the British Hydromechanics Research Association (BHRA) and National Engineering Laboratory indicated potential life extension factors of 10 - 50 times were possible on a variety of hydraulic equipment depending on oil contamination level.

Q. Our testing lab is moving to a new building. Do our testing systems require recalibration after the move?

A. We strongly recommended that you recalibrate your systems after a move. In fact, many ASTM and ISO testing standards, such as ASTM E4 and ISO 7500-1, have a mandatory requirement for recalibration.

Additionally, we recommend taking into account other appropriate services at this time including preventive maintenance, system set up, and training. If you have questions about this or you would like assistance with moving and recalibration of your system, please contact your local Instron service office.

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