How Materials Get the Creeps

Researchers have developed a comprehensive theory of creep flow—a type of flow seen in amorphous solids such as coffee foam.

By Ryan Wilkinson

Amorphous solids—including dense emulsions, foams, and granular materials—are important in both engineering and industry. When these substances are subjected to a suddenly imposed, constant stress, they can exhibit a transient phenomenon known as creep flow. Although creep flow has been studied extensively, a complete theory of this effect has been missing. Such a theory has now been devised by Marko Popović at the Max Planck Institute for the Physics of Complex Systems, Germany, and his colleagues [**1**].

When a material undergoes creep flow, its flow rate decays as a power law over time. This power law is characterized by a quantity called the creep exponent. If the stress inducing the creep flow is low, the material eventually stops moving. But if this stress is sufficiently high, the power-law decay can be followed by sudden fluidization—a process in which the material starts flowing like a fluid.

The theory presented by Popović and his colleagues can predict both the creep exponent and the time at which sudden fluidization occurs—as well as the temperature dependence of these two quantities. Such predictions are consistent with numerical simulations carried out by the researchers and with previously published experimental observations.

Credit: Yulia/stock.adobe.com

The central feature of the new theory is that creep flow is governed by changes in the maximum stress a material can sustain while deforming. Given the simplicity and generality of this theory, the researchers say that it will provide a key reference for future investigations into the mechanics of amorphous solids.

Ryan Wilkinson is a Corresponding Editor for *Physics Magazine* based in Durham, UK.

REFERENCES

1. M. Popović *et al.*, “Scaling description of creep flow in amorphous solids,” Phys. Rev. Lett. 129, 208001 (2022).