Flame-resistant cellular graphene aerogels and sensors

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Abstract

Protecting materials from fire damage is vital to many industrial and life safety applications. Although a handful of inherently flame-retardant materials exist, they are often expensive, brittle, or do not have suitable physical properties for the desired applications. Here we investigate structural and chemical changes of 2D graphene and 3D cellular graphene aerogels when exposed to different flames in air. We show that the arrangement of graphene flakes in the material strongly influences the flammability and combustion rate of graphene [1]. We demonstrate that free-standing graphene layers assembled into a 3D cellular structure exhibit 1000 °C higher flame resistance than 2D graphene on a substrate. The cellular graphene aerogels resist flames at a temperature of 1500 °C for a minute without degrading their structure or properties. Our findings reveal the exceptional fire-retardant and self-extinguishing properties of the cellular graphene aerogels, which can be used to for protecting materials from fire. Moreover, we demonstrate the use of the elastic graphene aerogels in tactile sensors [2,3]. We show the graphene aerogel sensors are fast and can operate over a very broad range of stress and strain both in compression and tension independently of the temperature.

References

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Figures

Figure 1: Flame-resistance testing of a cellular graphene aerogel using a propane flame.