Synthesis of Superelastic Graphene Aerogels

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Graphene aerogel is a three-dimensional porous form of graphene with a high surface-to-volume ratio. Graphene aerogels have attracted a significant amount of interest in recent years due to their unique mechanical and electrical properties that show great potential for numerous applications in engineering, electrochemistry, and biology. These unique properties are originating from a clever arrangement of two-dimensional graphene sheets in a three-dimensional porous monolith structure containing air-filled pores. Here, we report the synthesis and investigate the mechanical properties of superelastic graphene aerogels prepared via hydrothermal reduction of graphene oxide. The as-fabricated graphene aerogels, however, contain a lot of defects and oxygen groups which cause poor elastic properties. For this reason, we have thermally annealed the samples in a furnace in an inert gas atmosphere. The high-temperature annealing enabled a complete oxygen removal from the samples, resulting in a significant improvement of the elasticity of the graphene aerogels. The annealed graphene aerogels demonstrate superelastic compression up to a GPa pressure regime. To better understand the deformation mechanism in the samples we have performed in situ SEM measurements that visualized the deformation of individual graphene pores. Based on the observation we developed a model that is able to describe the stress-strain curves of the graphene aerogels. Our study provides new insights into the superelastic behavior and deformation mechanism of the porous graphene aerogels.