

## Description of Additional Supplementary Files

File Name: Supplementary Movie 1

Description: **Reduction of oxygen in graphene oxide**

The video shows a sequence of (false color) STEM images, which reveals the electron beam-induced reduction of oxygen in graphene oxide. Initially, an oxygen pair configuration is present, identified by the two brighter atoms. After several frames, the first oxygen atom gets sputtered leaving a monovacancy, which shows the dynamics as discussed in the manuscript. Then, the second oxygen atom gets kicked out leaving a divacancy.