Fabrication of a-phase AgI in graphene sandwiched structure under ambient temperature and pressure

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Silver iodide (AgI) has been known as a superionic conductor which is suitable material for electrolytes in all-solid-state batteries [1-3]. Since many types of current electronic devices mount the batteries, it is very important for us to improve their performances. One of the most promising systems is the all-solid-state one because of being safer than conventional batteries using liquid electrolytes. Then, efficient solid electrolytes are required for practical use, and the superionic conductor AgI crystal must be a hopeful candidate. AgI has three types of crystal structure; β and γ-phases showing hexagonal structure appear generally at normal temperature and pressure. In contrast, body centered cubic Φ#177;-phase crystal can be found only at high temperature condition above 420 K in a bulk system. It has been known that Φ#177;-phase AgI can exhibit superionic conductivity whereas β/γ-phases show no ionic conductivity. Therefore, adequate technologies to maintain the Φ#177;-phase even under the standard conditions has been required to be developed for industrial applications using superionic conductance of AgI.

Here, we have proposed a new method to fabricate Φ#177;-phase AgI at the normal temperature and pressure, in which micro droplets of AgI solution are confined in a graphene-graphene gap as shown in Figure 1. Graphene is a one-atom-thick carbon sheet, so that it is almost transparent to electron beam but is impervious to liquid molecules. This means that AgI solution sandwiched between graphene layers can be maintained inside the graphene capsule and be clearly observed with a transmission electron microscope (TEM). We have found that nanoparticles are generated from AgI solution during TEM observations, and these nanocrystals show the Φ#177;-phase structure.

Figure 1 shows a schematic illustration of the graphene sandwiched structure. Water and AgI molecules were packed between two layers of the monolayer graphene sheets. The inside liquid layer is not formed uniformly but dappled with various sizes. At the other region with no puddles, two graphene sheets contact with each other and they seal liquid molecules. Thickness of the liquid layer can be reduced to less than several tens of nanometers, depending on size of the puddles, which can provide atomic-resolution imaging. Figures 2(a) and (b) show a typical TEM image of the AgI particle sandwiched between graphene layers and its fast Fourier transformation (FFT), respectively. The FFT pattern of Fig. 2(b) represents tetragonal arrangement of spots, which from a distinctive body-centered cubic (bcc) crystal, i.e. a-AgI. Detailed procedures and results will be presented at the poster session.

References

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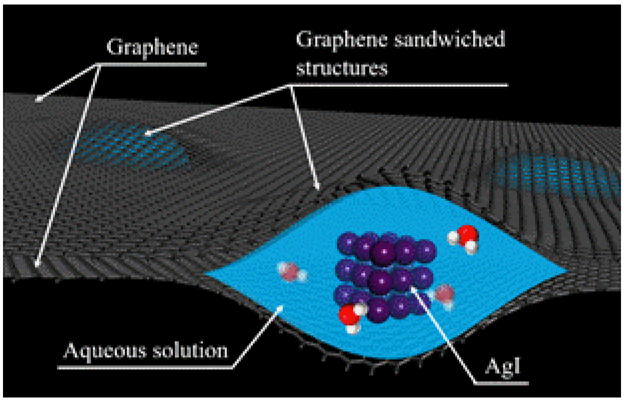

Figure 1. An illustration of water encapsulated inside graphene sandwiched structure.

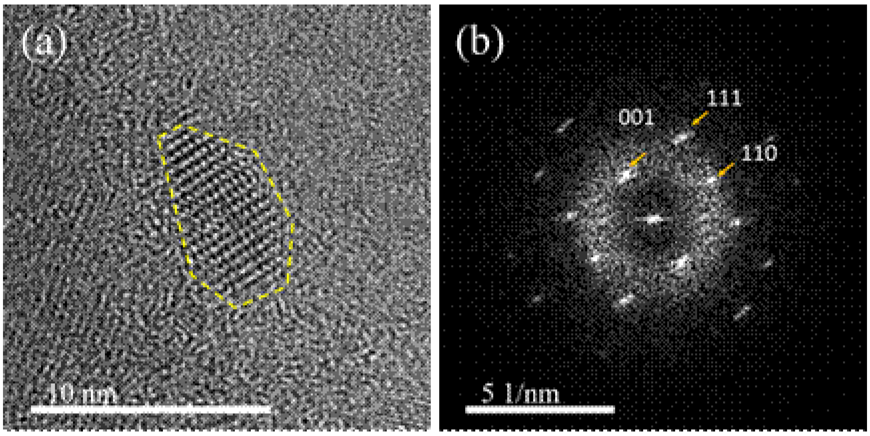

Figure 2. TEM image of AgI particle and its FFT pattern.