Melting Behavior and Morphology Change of Metallic Nanowires Using Femtosecond Laser Irradiation

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Abstract

In recent years, flexible electronics have attracted increased interests and attention, such as cell phones, sensors/biosensors, or other electronic devices. However, the assembly and bonding of electronic components or chips onto the flexible substrate are still challenging. One major issue is due to the fact that the melting temperature of the polymer substrates is usually much lower than that of metallic joining or soldering materials. Also, many electronic devices are getting smaller and lighter, and thus, smaller scale solder joints are difficult to form by conventional heating methods. In order to address these issues, the use of femtosecond laser has been proposed to enable micro/nano-scale solder joint formation on flexible polymer substrate. The ease of controlling the shape and location of the heating area leads to minimal component heating and the narrow laser beam enables melting at poorly accessible areas. In our research, the melting of nanowires was studied under femtosecond laser irradiation. Nanowires have been synthesized by electroplating in the nanopores of polycarbonate (PC) template. Different substrate, types of nanowires, heating time and heating circumstances were applied to study their influences to the morphology change of nanowire surface. It was found that the surface of the nanowires has significantly changed but the polyimide substrate remains undamaged after the laser irradiation. We also found that the laser caused different morphology change for different metals under the same irradiation conditions. Moreover, we observed ‘flower’ structure for Sn nanowires by heating them in air, or ‘bead’ structure by heating them in water. The study of the shape and morphology change can lead to a better understanding of laser melting process. The femtosecond laser heating can be used as a new soldering method to overcome some challenging issues, where the conventional soldering methods cannot be applied.