

Development of an Automated Microspotting System for Rapid Dielectrophoretic Fabrication of Bundled Carbon Nanotube Sensors

King W. C. Lai, Student Member, IEEE, Carmen K. M. Fung, Student Member, IEEE and Wen J. Li, Member, IEEE, Member, ASME

Abstract—An automated Carbon Nanotube (CNT) microspotting system was developed for rapid and batch assembly of bulk multi-walled carbon nanotubes (MWNT) based MEMS sensors. By using AC electrophoretic and microspotting technique, MWNT bundles were successfully and repeatably manipulated between an array of micro-fabricated electrodes. Preliminary experimental results showed that over 80% of CNT functional devices can be assembled successfully using our technique, which is considered to be a good yield for nanodevices manufacturing. Besides, the devices were demonstrated to potentially serve as novel thermal sensors for temperature and fluid-flow measurements. This feasible batch manufacturable method will dramatically reduce production costs and production time of nano sensing devices and potentially enable fully automated assembly of CNT based devices.

Index Terms— AC electrophoretic manipulation, carbon nanotube, CNT sensors, nano manufacturing, nano batch fabrication.

I. INTRODUCTION

Carbon nanotubes, has been widely studied for its electrical (e.g., see [1]), mechanical (e.g., see [2]), and chemical properties since its discovery in 1991 by Sumio Iijima [3]. Owing to their minute dimensions and the tendency to cling together in nature, it makes the connecting, aligning and isolating process of CNTs become difficult. To manipulate these nano-sized tubes, atomic force microscopy (AFM) is typically used to manipulate each of them one-by-one [4]. However, this is time-consuming and unrealistic when the process turns into batch production. Furthermore, researchers have recently demonstrated different novel methods in carbon nanotube manipulation using guided carbon nanotube growth [5][6], external forces [7][8], and polar molecular patterning [9]. Whereas the former refined technique grows organized carbon nanotube structures (directed assembly) by chemical-vapour deposition, the latter two methods are for pre-grown nanotubes. However, electric field is still better in isolating, aligning and

Manuscript received November 26, 2004. This work was funded by the Hong Kong Research Grants Council (CUHK4206/00E and 4381/02E), and the Chinese Academy of Sciences' Distinguished Overseas Scholar Grant.

King W. C. Lai, Carmen K.M. Fung and Wen J. Li are with the Centre for Micro and Nano Systems, The Chinese University of Hong Kong, Shatin, New Territories, Hong Kong SAR. Wen J. Li is also an affiliated professor at the Shenyang Institute of Automation, Shenyang, China (email: wen@acae.cuhk.edu.hk).