Electronic Supplementary Information for "Microwave synthesis of Cr nanowires on polymeric substrate"

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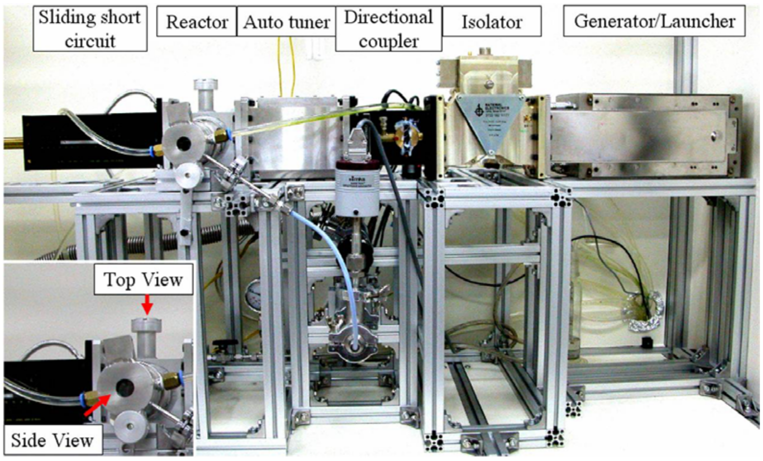
1. Experimental set-up for microwave irradiation system

The microwave irradiation system consists of four major parts. The first part is a microwave generating and cavity part as shown in Figure S1a. Microwaves are generated from magnetron (generator, 2.45 GHz, Max. 2 KW). The isolator and dummy load are required for the protection of magnetron from a reflected power. The directional coupler is required for the detection of forward and reflected microwave powers. The role of an auto tuner and a sliding short is the matching of microwaves in the microwave irradiation system. The single-mode cavity was used for effective and powerful heating based on concentrated microwaves. The second part is electricity supply system composed of power supply and automatic voltage regulator (AVR). The third and fourth parts are a gas supply and vacuum systems, respectively. The vacuum system is required to remove the air remaining inside the reactor before the growth of metal nanowires in order to protect metal nanowires against oxidation. The second, third, and fourth parts are showed in Figure S1b.

(a)



(b)

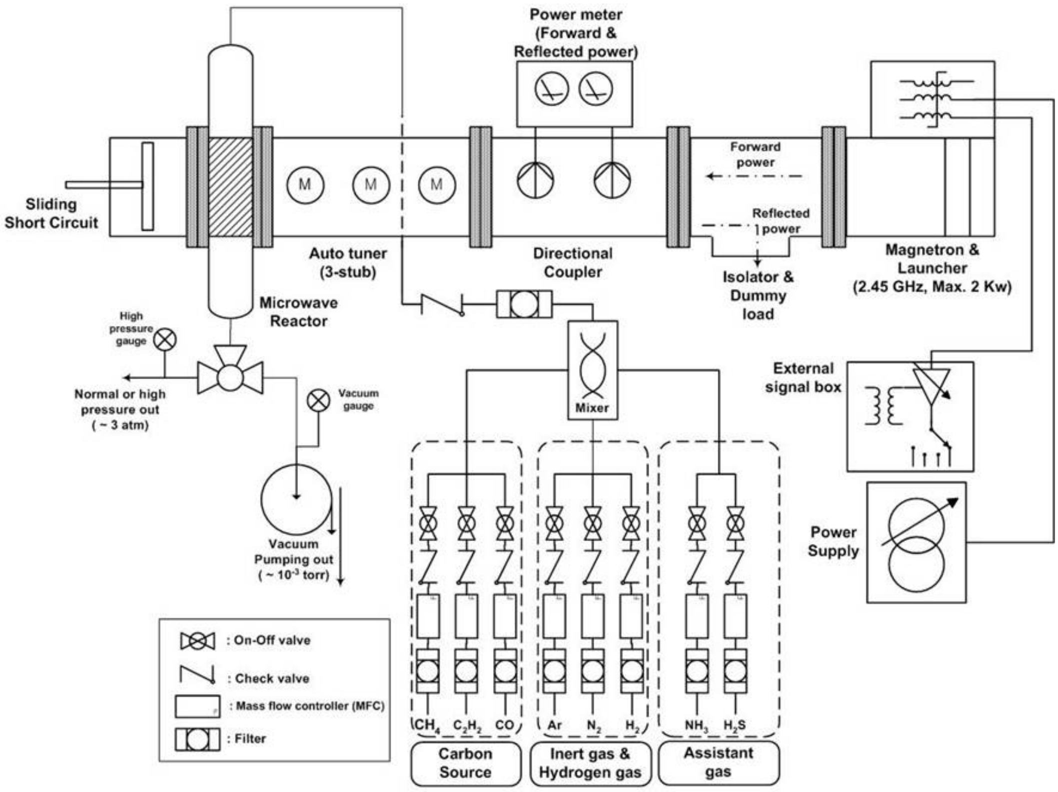


Figure S1. Microwave irradiation system. (a) A digital image of our microwave irradiation system. Inset is an enlarged view of the single-mode cavity. (b) A schematic diagram of microwave irradiation system.

2. Movies during the growth process of metal nanowires

Movie S1a and b show the top and side view real-time movies during the growth reaction of Cr nanowires on the Cr-coated Teflon substrate, respectively. It takes only 5 s for the growth of Cr nanowires. After mixed gas (20% H_2 and 80% Ar) was introduced into the reactor for 10 minutes, microwave was irradiated at the power of 300 W. The metal surface was heated by microwaves, and then random light spots were observed on the entire surface as shown in Movie S1a. From the real-time side view of the growth reaction, the light spots were only observed at the surface of Cr layer due to the selective heating of metal (see Movie S1b). Due to the selective heating effect, there was no noticeable damage to the Teflon substrate under our experimental conditions.

3. Standard deviations of the lengths and the radii of Cr nanowires

Figure S2a and S2b show standard deviations of the lengths and the radii of as-grown Cr nanowires, respectively. Standard deviations of the lengths and the radii of CrNW2 (Cr nanowires produced by 2 s microwave irradiation) were 280 and 6.2 nm, respectively. In case of CrNW5 (Cr nanowires produced by 5 s microwave irradiation), standard deviations of the lengths and the radii were 735 and 8.5 nm, respectively.

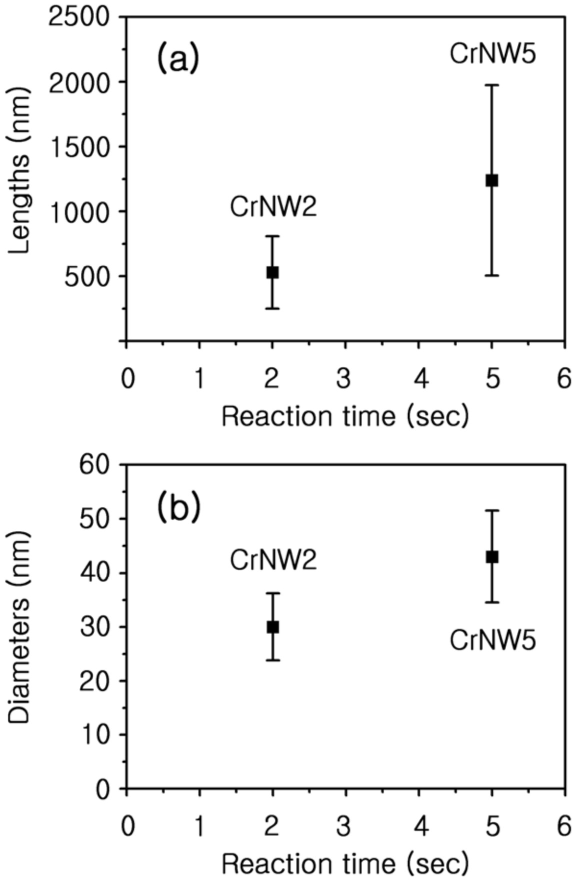


Figure S2. Plot showing the relationship (a) between reaction time and the estimated length and (b) between reaction time and the diameter of as-grown Cr nanowires. Black square dots represent the average length and diameter of Cr nanowires, and the standard deviation is shown as error bars.

4. Zn nanowires with carbon and fluorine contents

In order to verify the versatility of this microwave irradiation technique, Zn was used instead of Cr. Figure S3 shows the growth of Zn-alloy nanowires on the Teflon substrate after 5 s microwave irradiation at 300 W. While nanowires were successfully grown on the Teflon substrate, however, as-grown nanowires were not pure Zn nanowires as shown in Figure S3c-f. In Figure S3c-f, energy dispersive X-ray (EDX) analysis using TEM confirmed that Zn nanowires were formed, alloying with fluorine and carbon which were thought to be supplied from the Teflon substrate during the reaction. We can attribute the formation of Zn-alloy nanowire to the low melting point of Zn (419.5 ^{o}C). At present, we are trying to synthesize pure zinc nanowires on the Teflon substrate by avoiding alloy formation between zinc and Teflon. Generalization of this microwave irradiation technique to other metal nanowires is on-going.

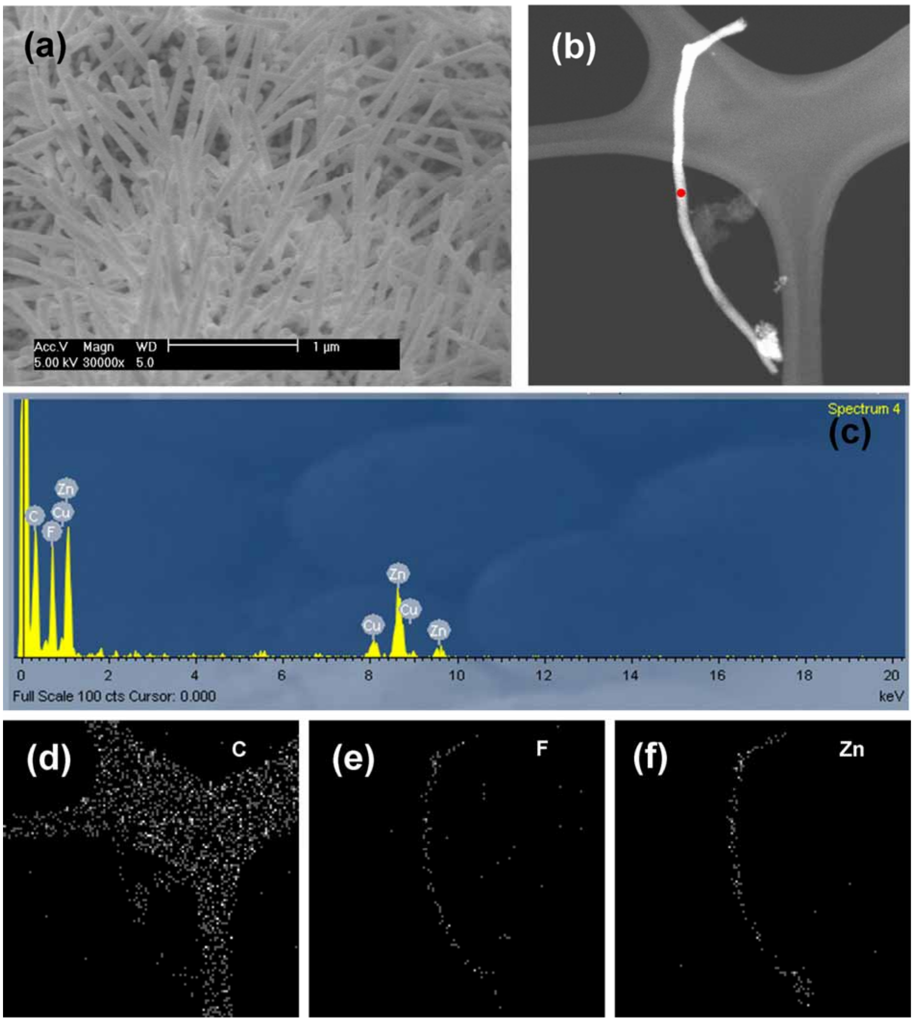


Figure S3. Growth of Zn nanowires on Teflon substrate with carbon and fluorine contents by the microwave irradiation technique. (a) A low magnification SEM image of as-grown nanowires. (b) A low magnification TEM image of an individual nanowire. (c) A TEM-EDX spectrum of as-grown nanowires at the red point in (b). (d-f) C, F, and Zn elemental mapping of the individual nanowire in (b).