142k Reaction Kinetics and Mechanism of Nickel Fiber Synthesis

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Nickel fibers, as shown in figure 1, were chemically synthesized from three different processes and their respective mechanisms and kinetics were investigated in this work. In the three processes, four reaction pathways were discovered indicating four different nickel precursors, which were $Ni(N_2H_3COO)_3^-$, $Ni(NH_3)_6^{2+}$, $Ni(N_2H_4)_3^{2+}$, and $Ni(OH)_2$ respectively. The activation energy of each reaction was determined to be 189.4 *kJ/mole*, 96.3 *kJ/mole*, 51.3 *kJ/mole*, and 13.4 *kJ/mole*. From SEM analysis the morphologies were found to be different in size and structure according to the reaction conditions. Since the nickel fibers were basically formed by the connection of nickel particles under the magnetic field, the variation in thickness of the fiber could therefore be explained by the rate of nucleation and subsequent growth. For stable nickel complexes such as $Ni(N_2H_3COO)_3^-$ and $Ni(NH_3)_6^{2+}$, the nucleation rate was relatively slow, and there were fewer nuclei generated, so the diameter of nickel fibers became larger. On the contrary, when more nuclei were generated, the diameter of nickel fiber was smaller. At the same time, the structure of nickel fibers was also affected by growth rate. Excessively high growth rate would cause weak connection between nickel particles and hence a loose structure as shown in figure 2. In the most extreme case, only nickel powder was obtained.

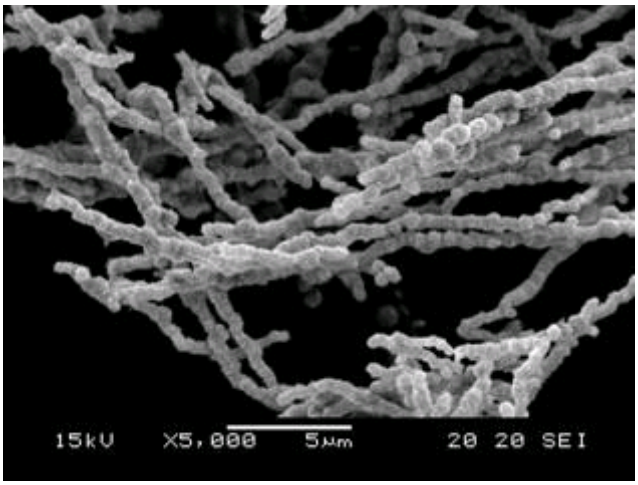

Fig. 1 Nickel fibers synthesized from process III

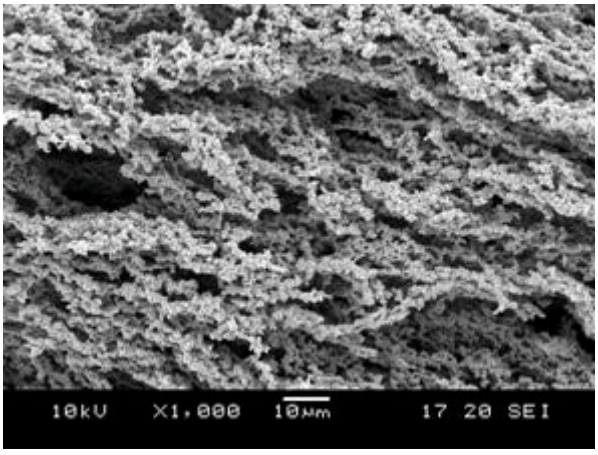

Fig. 2 Products in process II when the growth rate was too high