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Characteristics of Nanoparticles Emitted From Kanthal A1 and Nichrome Heaters Used in Electronic Cigarettes

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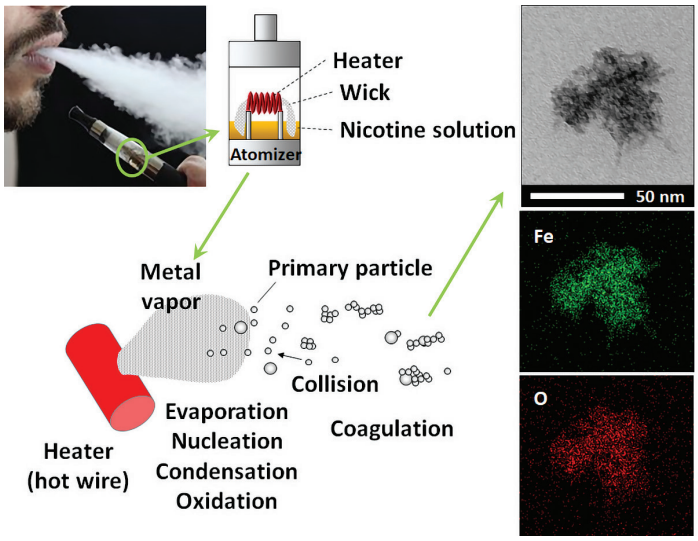
Electronic (e-) cigarettes simulate the experience of smoking traditional cigarettes but are known to be less harmful. The e-cigarette consists of a metallic coil heater to vaporize nicotine solution, a reservoir containing nicotine solution, and a wick to deliver nicotine solution to the heater. As one of the main components in the E-cigarette, the metallic coil could be a potential source of exposure to toxic metals. When the heater is operating, metal vapor can be produced from the heater surface, cooled by air, and then proceed to form nanoparticles (<100 nm) through condensation, nucleation, and coagulation.



Depiction of nanoparticle emission on TEM and EDX. (Retrieved from medicalxpress.com.)

In this study, metallic nanoparticles produced from Kanthal A1 (iron + chromium + aluminum) and Nichrome (nickel + chromium + iron) heaters were characterized. The size distribution of airborne particles emitted from each test heater was measured using a scanning mobility particle sizer (SMPS) for 30 minutes. The nanoparticles were visualized and chemically characterized under a transmission electron microscope (TEM) and energy dispersive x-ray spectroscopy (EDX), respectively. Under normal conditions (Heater Resistance: 0.5Ω, Applied Power: 10W), the initial number median diameter of airborne particles was maintained under 50 nm for both Kanthal A1 and Nichrome heaters. The initial total number concentration (TNC) of particles from Kanthal A1 and Nichrome heaters were 1.1×10^6 particles/cm^3 and 1.9×10^6 particles/cm^3, respectively. In all cases, the TNCs decreased over time because surface oxidation (metal oxide layer on heater surface) prevented further nanoparticle formation. As a result, a used heater may reduce the risk of the metal exposure from e-cigarettes.

Research advisor Jae Hong Park writes: "Kaushal found that a used heater could generate fewer nanoparticles than a new heater. This result is important to determine the potential risk of e-cigarettes. Furthermore, his system and method are useful to conduct inhalation toxicology studies for assessing health impacts of e-cigarettes and support the development of safer e-cigarette systems."

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