Printing 2D MXene-Based Chipless Radio Frequency Identification Tags to Enable Plastic Waste Sorting for Recycling

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Plastic recycling is limited by mis-sorting across polymer families and additives. Current identification methods, such as SPI resin codes, labels, and visible/near-infrared/Fourier Transform infrared (VIS/NIR/FTIR) sorting, often fail for dark or filled plastics, multilayer materials, and contaminated packaging. We introduce a printable, chipless radio frequency identification (RFID) tag based on high-conductivity MXene traces protected by an ultrathin polyvinyl alcohol (PVA) film. The tag provides robust, remote identification, yet detaches/disperses in the standard alkaline, elevated-temperature wash already used in recycling processing, preventing contaminant carryover. We engineer resonant geometries for RFIDreadability, quantify oxidation-limited drift, and show that an ultrathin PVA film slows oxygen ingress to preserve conductivity and read range over storage and use. In simulated wash lines (1–2% NaOH, 60–85 degrees Celsius), both MXene and PVA dissolve rapidly, yielding effective removal and negligible residue on flakes. This approach enables accurate pre-recycling sortation without compromising downstream polymer quality, offering a practical path to efficient and higher-purity recycled streams.

Awards Won:

First Award of $6,000

Craig R. Barrett Award