Enhanced Corrosion Resistance of Aluminum Matrix Composites reinforced with TiC via Spark Plasma Sintering

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Abstract Aluminum Matrix Composites (AMCs) are advanced materials formed by aluminum matrix combined with a variety of particulate or fiber as reinforced phases. These composites reinforced with ceramics, metals, or carbon fibers that leads to increased strength, stiffness, wear, and corrosion resistance are designed to improve the mechanical properties of aluminum for a wider range of applications like the lightweighting needs of aerospace and automotive field[1].

In the present research, AMCs synthesized via spark plasma sintering (SPS) combined AA2024 as the matrix with TiC nanoparticles as the reinforcing phase. The incorporation of TiC, in varying concentrations from 0% to 8%, was systematically analyzed to assess its effects on the composites' microstructure and corrosion behavior. The results indicate that the secondary phase of the matrix was mainly distributed inside the grains, while TiC was distributed along the grain boundaries and agglomerated at higher contents. The corrosion resistance of AMCs improved and then declined with increasing TiC content demonstrated by electrochemical tests and immersion tests. The composites with 4% TiC exhibited the minimum of corrosion current density and pitting depth, and possessed largest capacitance arc and polarization resistance. Re-passivation occurred in the corroded area during the extension of pits to decelerate the corrosion process, however excessively high TiC content could potentially induce the breakdown of the re-passivated film. The addition of a small amount of TiC could reduce the rate of galvanic corrosion due to a lower potential difference between Al and TiC, while the passive film was more stable and flatter with reduced adsorption of Cl^- and cation vacancy density, which mitigated the dissolution of passive film[2]. Uneven distribution and agglomeration of TiC by excessive content promoted the elevated adsorption of Cl^- which led to local rupture of the passive film and dissolution of anode Al, and accelerated the corrosion process[3].

Keywords Corrosion, Electrochemical, Aluminum matrix composite

Reference

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