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MMFX Microcomposite Steel (MMFX2)

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MMFX MICROCOMPOSITE STEEL (MMFX2)

THE NEED

One of the major problems facing the construction industry today is the effect of corrosion on steel, and the inherent structural weaknesses it causes in highways, bridges and buildings. The need for corrosion-resistant steel is illustrated by the billions of dollars required annually to reconstruct or repair structures whose design life has been either shortened or eliminated as a result of corrosion, or through loss of aesthetic value or functional obsolescence. Irrespective of the replacement costs of steel products (i.e. reinforced concrete, structural steel members, ship plate, etc.), personal injury and deaths have occurred through corrosion-induced structural failures.

FIGURE 1 MMFX STEEL REBAR

THE TECHNOLOGY

MMFX 2 rebar was developed through the use of nanotechnology by Dr. Gareth Thomas, graduate school professor of materials science at Univ. of California, Berkeley. It is highly corrosion resistant and equal, or in many cases, far superior to existing conventional carbon steel in its properties of strength, energy absorption, toughness, brittleness, ductility, and formability. In addition, MMFX steels is also economical to produce and install. MMFX steel achieves its superior properties of corrosion resistance as a result of the patented and proprietary steel microstructure that is formed during production. Its proprietary material composition and production processes minimize

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the formation of mircogalvanic cells, a significant contributor to the initiation and acceleration of corrosion activity.

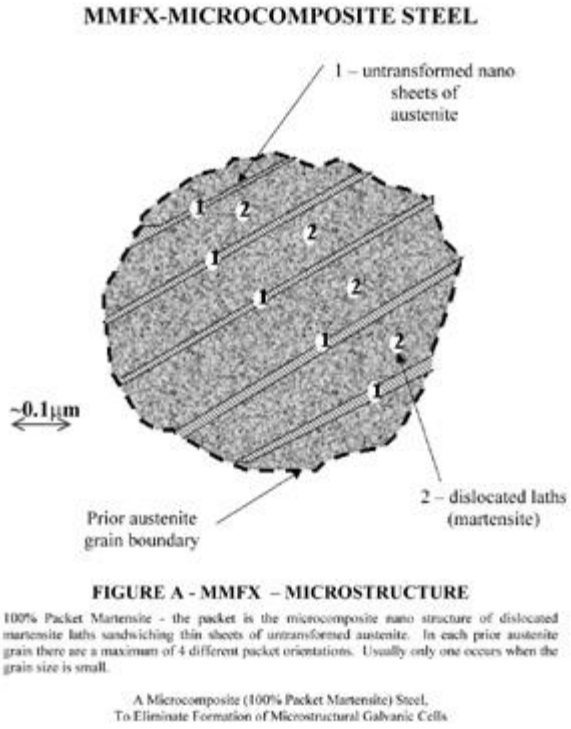

FIGURE 2 MMFX-MICROCOMPOSITE STEEL

MMFX Steel's proprietary chemical composition and production process control the steel's martensitic microcomposite microstructure as shown in Figures A and B. MMFX's designed microstructure consists of untransformed nano sheets of austenite between laths of dislocated martensite, resulting in a virtually carbide free steel. Without the creation of continuous paths of carbides, microgalvanic cell formation is minimized during MMFX's production. Reduction of mircogalvanic cell formation in MMFX steels are demonstrated by viewing their microstructures. Material microstructural properties are characterized utilizing transmission electron microscopy (TEM) techniques as illustrated in Figure B and are observed through use of electron microscopes. Hence, the control of MMFX steel's morphology (form and structure) of its microstructure has resulted in its significantly superior material properties. MMFX's microstructure not only provides the primary mechanism for its high corrosion resistance but also contributes to its superior mechanical properties of high strength with ductility, high fatigue resistance, and low temperature brittle fracture resistance. These material properties lead to longer service live in corrosive environments and lower construction costs. MMFX's superior strength provides an opportunity to save construction costs and materials along with simplifying placement of concrete, as a result of greater bar

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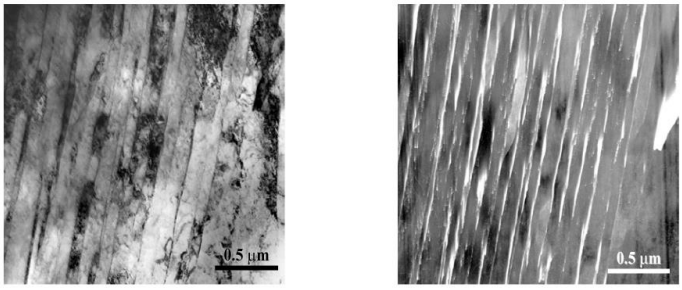
spacing, in heavily reinforced concrete structures. In addition, MMFX's superior corrosion resistance offers the potential opportunity to reduce concrete cover in certain structures needed as a result of the corrosive environments in which they are constructed.

MMFX STEEL – MICROSTRUCTURE

Transmission Electron Microscopy (TEM)

Microstructure of Nano Sheets of Austenite
In Carbide Free Lath Martensite



Bright Field image (BF) **Dark Field image (DF)**

FIGURE B – MMFX – TEM PACKET LATH MARTENSITE MICROGRAPH

FIGURE 3 MMFX STEEL – MICROSTRUCTURE

Field installation can further be simplified as MMFX's monolithic composition means that: 1. Field handling will not damage MMFX as can occur to coated products requiring field touch up of field damaged coatings, 2. Standard field rebar fabrication procedures are possible with MMFX vs. special requirements for offsite cutting and bending of coated products and special requirements to place protective end caps for cladded products, and 3. No special field erection safety hazards exist for MMFX, as can occur on slick epoxy coated surfaces. All of these product qualities add up to potential significant costs savings through the use of MMFX and are seen both during installation and throughout the life of the project.

THE BENEFITS

- Highly corrosion resistant without use of coating technologies resulting in extended service life of rebar in corrosive environments.
- High design yield strength (100ksi) - reducing rebar quantities & simplifying field installation, which can result in reduced construction costs associated with concrete structure.
- Standard field fabrication techniques applicable.

STATUS

Microcomposite Steel's material and structural properties have been tested and analyzed at various public and private laboratories and institutions to provide structural, mechanical and corrosion resistance data

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to certify MMFX for use by public agencies, private corporations and other interested parties. These institutions include: TEES (Texas Engineering Experimental Station) Texas A&M University, HITEC (Highway Innovative Technology Evaluation Center) and various universities. (Click here for the test results)

MMFX Rebar Project Applications:

- Iowa Bridge Deck - MMFX rebar was incorporated into new bridge deck reinforcement for an Iowa DOT project located in GundyCounty Iowa.
- Oklahoma Bridge Girders - MMFX rebar is used as stirrups in precast bridge girders for an Oklahoma DOT project
- Florida Residence Slab - MMFX rebar was placed as reinforcement in a residential house slab in a highly corrosive coastal environment

MMFX was granted ASCE's CERF/IIEC 2002 Charles Pankow Award for Innovation.

Barriers

Various market entry barriers exist to new and innovative products, as these new products many times are not covered by existing material standards or are not included in the existing building codes. In order to overcome thesemarket entry barriers MMFX Technologies is moving ahead in following areas of material specification and codification required for product certification: ASTM material specification, ACI product appraisal and material submission to the ACI 318 committee for inclusion in future design codes, and AASHTO (American Association of State Highway and Transportation Officials) standard material specification.(Click here for the status of material standards and codification)

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REVIEWERS

Peer reviewed as an emerging construction technology

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