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PROCESSING SILICON CARBIDE FIBERS FROM ORGANOSILICON PRECURSORS

by

Zhi-Fan Zhang

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Materials Science and Engineering)
in The University of Michigan
1994

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Associate Professor John W. Holmes
Professor Tseng Y. Tien

This dissertation is dedicated to
my parents,
Mr. Xin Zhang and Mrs. Hua-Ze Zhu,
and my sister,
Ms. Zhi-Wen Zhang

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INTRODUCTION

Continuous, high temperature stable ceramic fibers, when incorporated into ceramic matrices, provide composites with high temperature mechanical properties that are superior to the unreinforced matrix materials.[1-4] The first reinforcing fibers produced on a commercial basis in large quantities were silica-alumina glass fibers.[3] Although these fibers provided superior polymer composite materials, their low elastic moduli (<100 GPa) made them unsuitable for reinforcement in ceramic matrices.[1-3] Furthermore, their tensile strength decreases from 3 to 4 GPa, at ambient temperature, to ≈ 1 GPa at 600°C,[2] an additional disadvantage for use in ceramic matrices.

Carbon fibers, with elastic moduli of 200 to 500 GPa and tensile strengths of 1.5 to 3 GPa, were the second type of inorganic reinforcing fibers commercialized. However, except in special cases, their application temperatures are limited to < 500°C due to carbon's poor oxidation resistance.[1-3] The need for better high temperature structural materials has motivated materials scientists to develop alternative methods of producing ceramic based reinforcing fibers which exhibit high elastic moduli and tensile strengths at temperatures above 1200°C.

During the last 15 years, several varieties of these high temperature ceramic fibers have been developed.[5-28] Among these, SiC fibers, with their potential high temperature stability (> 1500°C) , high modulus (> 300 GPa) and high strength (> 3 GPa), have received a great deal of attention for applications in high temperature composite materials. Two commercial approaches have been developed to produce these SiC-based continuous fibers. One approach is the Textron (originally AVCO) chemical vapor deposition process