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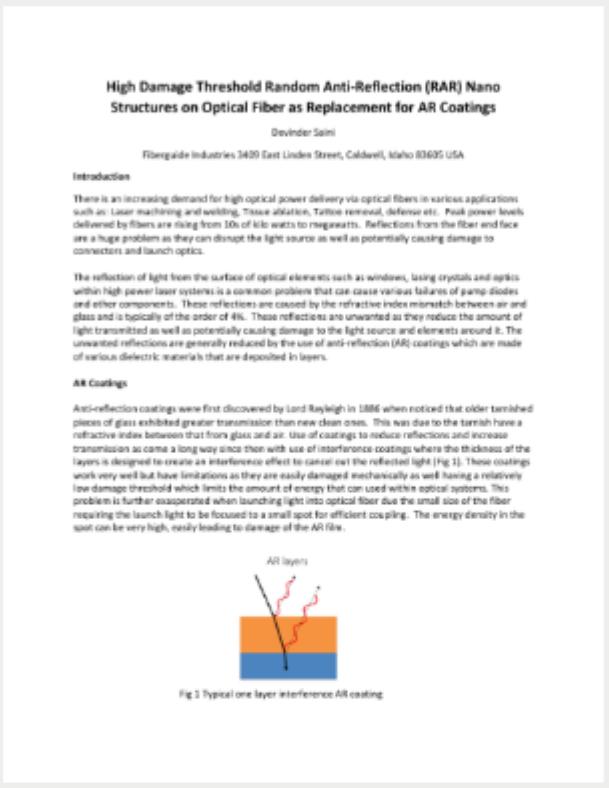

High Damage Threshold Random Anti-Reflection (RAR) Nano Structures on Optical Fiber as Replacement for AR Coatings

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Introduction

There is an increasing demand for high optical power delivery via optical fibers in various applications such as: Laser machining and welding, Tissue ablation, Tattoo removal, defense etc. Peak power levels delivered by fibers are rising from 10s of kilo watts to megawatts. Reflections from the fiber end face are a huge problem as they can disrupt the light source as well as potentially causing damage to connectors and launch optics.

The reflection of light from the surface of optical elements such as windows, lasing crystals and optics within high power laser systems is a common problem that can cause various failures of pump diodes and other components. These reflections are caused by the refractive index mismatch between air and glass and is typically of the order of 4%. These reflections are unwanted as they reduce the amount of light transmitted as well as potentially causing damage to the light source and elements around it. The unwanted reflections are generally reduced by the use of anti-reflection (AR) coatings which are made of various dielectric materials that are deposited in layers.

AR Coatings

Anti-reflection coatings were first discovered by Lord Rayleigh in 1886 when noticed that older tarnished pieces of glass exhibited greater transmission than new clean ones. This was due to the tarnish have a refractive index between that from glass and air. Use of coatings to reduce reflections and increase transmission as come a long way since then with use of interference coatings where the thickness of the layers is designed to create an interference effect to cancel out the reflected light (Fig 1). These coatings work very well but have limitations as they are easily damaged mechanically as well having a relatively low damage threshold which limits the amount of energy that can used within optical systems. This problem is further exasperated when launching light into optical fiber due the small size of the fiber requiring the launch light to be focussed to a small spot for efficient coupling. The energy density in the spot can be very high, easily leading to damage of the AR film.

Fig 1 Typical one layer interference AR coating

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This particular paper covers the key elements of anti-reflective coatings and the comparable improvement in the performance of the fiber through the application of a nano structure surface. More specifically, the paper focuses on a structure which mimics a moth's eye and how the application of this new process pushes the capabilities to new heights for consumers within multiple industries.

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