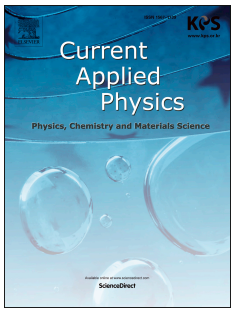
Accepted Manuscript



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PII: S1567-1739(16)30312-1

DOI: 10.1016/j.cap.2016.10.019

Reference: CAP 4354

To appear in: *Current Applied Physics*

Received Date: 26 July 2016

Revised Date: 13 September 2016

Accepted Date: 26 October 2016

Please cite this article as: J. Ko, H. Jeong, S.Y. Choi, F. Rotermund, D.-I. Yeom, B.Y. Kim, Single-walled carbon nanotubes on side polished fiber as a universal saturable absorber for various laser output states, *Current Applied Physics* (2016), doi: 10.1016/j.cap.2016.10.019.

Single-walled carbon nanotubes on side polished fiber as a universal saturable absorber for various laser output states

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Abstract

We demonstrated four different laser operational states in the same passive fiber ring laser cavity by controlling solely the polarization state in a saturable absorber. The demonstrated laser operational states were continuous wave, mode-locking, Q-switching, and Q-switched mode-locking. The saturable absorber was fabricated by spin-coating a single-walled carbon nanotubes (SWCNT)/polymer composite on a side polished fiber providing enhanced nonlinear interaction with the SWCNT. The wide tuning range of the saturable absorber allows the simple means to generate different forms of laser output from a single laser cavity.

Keywords: Single-walled carbon nanotubes; passive fiber lasers; mode locked lasers; Q-switched lasers

1. Introduction

Optical pulse generation in fiber lasers where active modulators are replaced by nonlinear optical components such as saturable loss elements have been extensively studied for their simplicity and high performance[1–7]. Depending on the desired properties of the pulses, different forms of nonlinear optical elements optimized for particular output form such as mode locked (ML) and Q-switched pulses have been used[1–12]. In contrast, recent works using graphene and graphene oxide interacting with evanescent field of a fiber mode as saturable absorber (SA) produced different laser output states from a single laser cavity[13,14]. Although introduced prior to the graphene SAs, single-walled carbon nanotubes (SWCNTs) have not been used to generate multiple laser output states from a single laser cavity. One of the difficulties in producing multiple output states is that many laser parameters including saturable loss and saturable gain in the cavity have to be adjusted differently for each output modes[15,16]. We note that a SA with a large tuning range for the saturable loss and saturation intensity can provide much simpler ways to control the laser output state.

In this paper, we propose, analyze, and demonstrate the use of SWCNTs in a fiber laser cavity as a SA having a large tuning range of key laser parameters for the generation of different output states from a single cavity. The SA was fabricated by spin-coated SWCNT/polymer composite on a side-polished fiber (SPF) to produce strong interaction with the SWCNT without significant background scattering loss. We describe details of the fabrication process along with its linear and nonlinear optical properties. Different laser output states are demonstrated using the universal SA including continuous wave (CW), ML pulses, Q-switched pulses and Q-switched mode-locked

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