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14. ABSTRACT

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RPPR Final Report
as of 28-Jan-2020

Agency Code:

Proposal Number: 70127ELRIP **Agreement Number: W911NF-17-1-0264**

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Report Date: 14-Sep-2019 Date Received: 12-Jan-2020
Final Report for Period Beginning 15-Jul-2017 and Ending 14-Jun-2019

Title: Femtosecond Amplifying and Harmonic Generation System for Ultra-High Frequency Spintronics

Begin Performance Period: 15-Jul-2017 **End Performance Period:** 14-Jun-2019
Report Term: 0-Other

Submitted By: PhD Kang Wang Email: wang@ee.ucla.edu
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STEM Degrees: **STEM Participants:**

Major Goals: The femtosecond amplifying and harmonic generation system sponsored by this award will be integrated with our existing magneto-optical characterization system and the anomalous Hall transport measurement system to provide needed capabilities and support our research programs mainly on magnetoelectronics and spinorbitronics in topological and magnetic hetero-structures and nano-devices. With the incorporation, an ultrashort laser pulse with pulse width of < 40 fs, wavelengths tunable between 400 nm and 2,600 nm, and sub-micrometer spatial scale will be achievable, accelerating the progress in basic science and practical application research of innovative THz spintronic nano-devices. Our current researches particularly aim to understand the ultra-fast magnetism, switching and high-frequency resonances at topological interfaces and in other nanomaterials and their hetero-structures. With this femtosecond amplifying and harmonics generation system, we will be enabled to study the physics and mechanisms of highly energy efficient spintronics at ultrashort temporal scales and ultrahigh frequency and at the nano-scale spatial resolution. Thus, a pioneering physical mechanism or technique could be realized to progress the development of information technology. Combining with ferrimagnetic/antiferromagnetic materials which possess high intrinsic spin precession frequency, this instrumentation especially offers an excellent opportunity to demonstrate an improvement in magnetization switch speed, which has been one of the major directions in spintronics area. This will definitely help continual advancement in high-speed spintronic devices and THz applications for information technology.

Accomplishments: - Incorporated the femtosecond amplifier and harmonic generation system with our existing femtosecond oscillator and magneto-optical characterization system to achieve the following capabilities: (i) sub-micrometer spatial resolution; (ii) an intense pump pulse beam with a fluence of approximately 1.0 mJ/cm2; (iii) temporal resolution of <40 fs; (iv) tunable wavelength range between 400 nm and 2,600 nm for pump and probe laser.
- Successfully designed integrated Auston switch with standard Hall bar structure on Ta/GdFeCo thin films and achieve sub-picosecond laser-excited current pulses injection into the Ta/GdFeCo Hall bar to study SOT-related physics.
- Empowered by the high-power pulse generated by the amplifier under this award, sub-picosecond photocurrent pulses with peak amplitude up to 200mA were successfully generated for sequential study on the SOT-driven ultrafast magnetization dynamics in the Ta/GdFeCo heterostructures.
- Empowered our capability of enlarging and detecting using second-harmonic generation to distinguish and perceive the embedded signal in our magneto-optical Kerr (MOKE) measurements and to increase the signal-to-noise ratio of our optical pump-probe setup significantly.
- Demonstrated robust and spin-orbit torque (SOT) driven magnetization switching of ferrimagnetic GdFeCo on a picosecond timescale by the observation of the changes in anomalous Hall resistance and Kerr rotation

RPPR Final Report
as of 28-Jan-2020

Training Opportunities: Nothing to Report

Results Dissemination: Nothing to Report

Honors and Awards: Nothing to Report

Protocol Activity Status:

Technology Transfer: Nothing to Report

PARTICIPANTS:

Participant Type: PD/PI
Participant: Kang Lung Wang
Person Months Worked: 1.00 **Funding Support:**
Project Contribution:
International Collaboration:
International Travel:
National Academy Member: N
Other Collaborators:

Title: Femtosecond Amplifying and Harmonic Generation System for Ultra-High Frequency Spintronics

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