2D MoS_2 post-synthesis improvement of optical and electronics properties

E. Sangiorgi[1], A. Madonia[1], F. Migliore[1], S. E. Panasci,[2] E. Schilirò,[2] F. Giannazzo[2], F. Esposito[3,4], L. Seravalli[3], G. Buscarino[1,5], M. Cannas[1], S. Agnello[1,2,5]

1 Department of Physics and Chemistry Emilio Segrè, University of Palermo, Palermo (Italy) **2** Consiglio Nazionale delle Ricerche - Istituto per la Microelettronica e Microsistemi (CNR-IMM), Catania (Italy) **3** Consiglio Nazionale delle Ricerche – Institute of Materials for Electronics and Magnetism (IMEM-CNR), Parma (Italy) **4** Department of Mathematical, Physical and Computer Sciences, University of Parma, Parma (Italy) **5** ATEN Center, University of Palermo, Viale delle Scienze Ed. 18, 90128 Palermo, Italy

Introduction

- Monolayer MoS_2 (**1L-MoS_2**) is a widely studied **2D material**, known for its direct band gap and **strong light emission**, resulting from exciton recombination in the visible range
- It figures out as a promising material for **optoelectronic nanodevices** based on 2D semiconductive materials;
- Tuning 1L-MoS_2 properties is challenging because they are **strongly affected by the synthesis methods**.
- In this work, 1L-MoS_2 **mechanical exfoliated and Chemical Vapor Deposition** supported by **different substrates (Au, SiO_2/Si)** is treated in **thermally controlled conditions,** tuning its strain-doping conditions.

Conclusions

- Thermal treatment induces controlled changes in **initial tensile strain and doping**;
- Regardless of the synthesis used, the intensity of **luminescence has been improved**;
- Treatments **reduce n-type doping**, probably induced by carbon contamination;
- Exposure to oxygen during the treatment **could fill the sulfur vacancies**, which act like trapping states;
- AFM shows **no damage** and **cleaning** of the surface of the flakes after the treatments;

Results

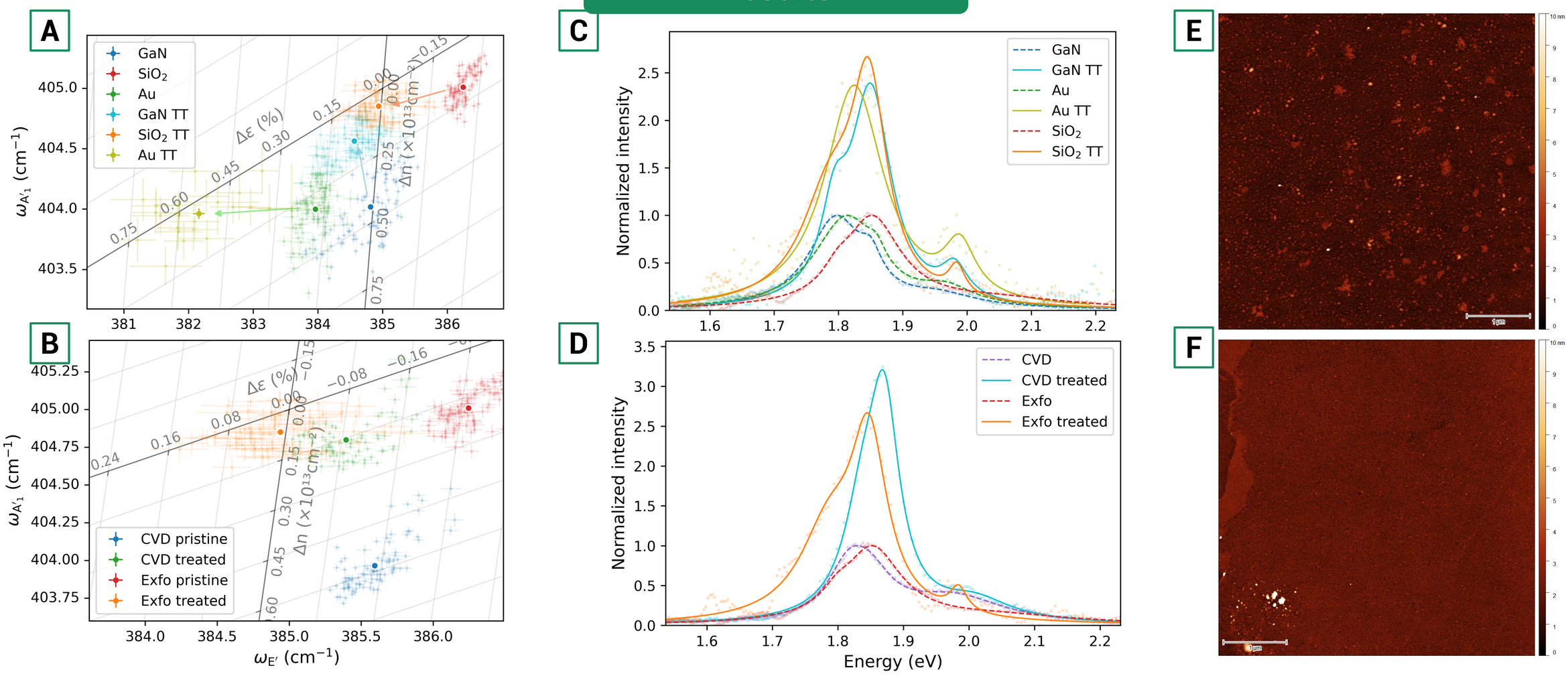
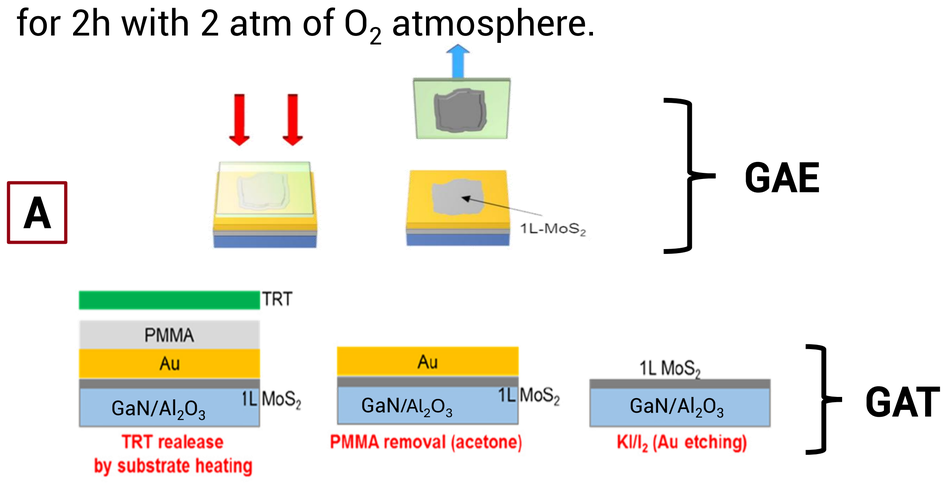


Figure 1: Strain-doping maps of: 1L-MoS_2 on Au, SiO_2, and GaN substrate before and after thermal treatment 225°C in O_2 for GAE and GAT samples **A)**; strain-doping maps of 1L-MoS_2 on SiO_2 prepared by GAE/GAT and CVD before and after thermal treatments **B);** Normalized fluorescence spectra of 1L-MoS_2 on Au, SiO_2, and GaN substrate before and after thermal treatment GAE and GAT **C)**;. Normalized fluorescence spectra of 1L-MoS_2 on SiO_2 GAT and CVD before and after thermal treatment **D)**; AFM image (tapping mode) of 1L-MoS_2 on Au before **E)** and after **F)** thermal treatment in O_2.

Materials & Methods

- MoS_2 on Au substrate by **Gold-Assisted-Exfoliation** (GAE); MoS_2 on SiO_2/Si and GaN by **Gold-Assisted Transfer** (GAT); MoS_2 on SiO_2/Si prepared by **Chemical Vapor Deposition** (CVD) with liquid precursors;
- Thermal treatment performed with a **Linkam® cell**, in-situ at 225 °C for 2h with 2 atm of O_2 atmosphere.



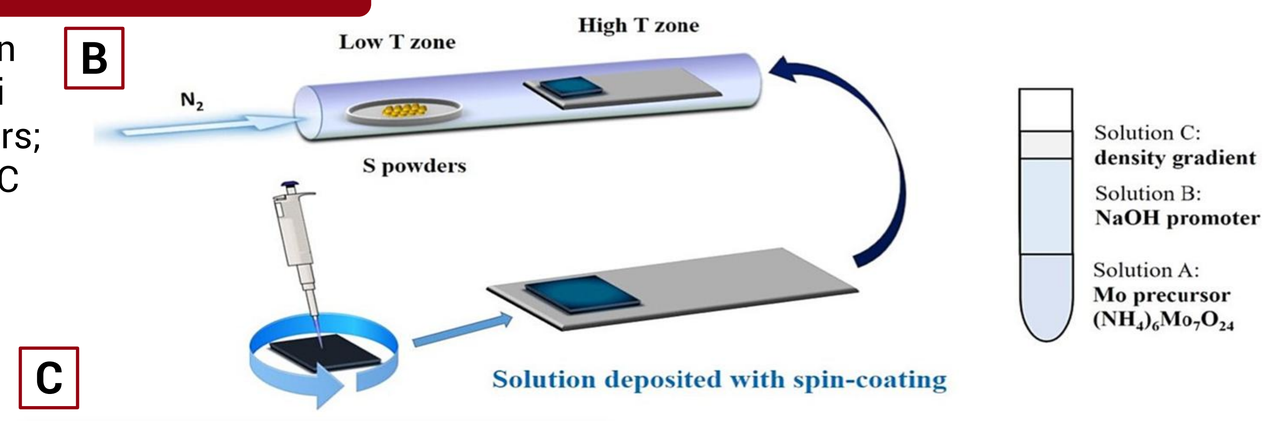


Figure 2: Scheme of Gold-Assisted Exfoliation and Gold-Assisted Transfer **A)**; Scheme of Chemical Vapour Deposition with liquid precursors **B)**; Image of the Linkam® cell used to perform the thermal treatments **C)**.

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