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标题: Phase diagram of the ultrafast photoinduced insulator-metal transition in vanadium dioxide
作者: Cocker, TL (Cocker, T. L.); Titova, LV (Titova, L. V.); Fourmaux, S (Fourmaux, S.); Holloway, G (Holloway, G.); Bandulet, HC (Bandulet, H. -C.); Brassard, D (Brassard, D.); Kieffer, JC (Kieffer, J. -C.); El Khakani, MA (El Khakani, M. A.); Hegmann, FA (Hegmann, F. A.)
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摘要: We use time-resolved terahertz spectroscopy to probe the ultrafast dynamics of the insulator-metal phase transition induced by femtosecond laser pulses in a nanogranular vanadium dioxide (VO2) film. Based on the observed thresholds for characteristic transient terahertz dynamics, a phase diagram of critical pump fluence versus temperature for the insulator-metal phase transition in VO2 is established for the first time over a broad range of temperatures down to 17 K. We find that both Mott and Peierls mechanisms are present in the insulating state and that the photoinduced transition is nonthermal. We propose a critical-threshold model for the ultrafast photoinduced transition based on a critical density of electrons and a critical density of coherently excited phonons necessary for the structural transition to the metallic state. As a result, evidence is found at low temperatures for an intermediate metallic state wherein the Mott state is melted but the Peierls distortion remains intact, consistent with recent theoretical predictions. Finally, the observed terahertz conductivity dynamics above the photoinduced transition threshold reveal nucleation and growth of metallic nanodomains over picosecond time scales.
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地址: [Cocker, T. L.; Titova, L. V.; Holloway, G.; Hegmann, F. A.] Univ Alberta, Dept Phys, Edmonton, AB T6G 2E1, Canada
[Fourmaux, S.; Bandulet, H. -C.; Brassard, D.; Kieffer, J. -C.; El Khakani, M. A.] Univ Quebec, INRS EMT, Varennes, PQ J3X 1S2, Canada
通讯作者地址: Cocker, TL (通讯作者),Univ Alberta, Dept Phys, Edmonton, AB T6G 2E1, Canada
电子邮件地址: tcocker@gmail.com; hegmann@ualberta.ca
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