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SHOCK WAVE SYNTHESIS OF OXYNITRIDE SPINELS

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We have successfully recovered spinel-type high-pressure phase of oxynitride sialon in the post-shock samples. The spinel has been characterized by analytical electron microscopy, nmr spectroscopy, and xrd measurements. The spinel coexists with a large amount of amorphous phase, depending upon the shock condition. We have developed the purification and separation method for the oxynitride spinel.

Keywords: SPINEL SHOCK WAVE OXYNITRIDE

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HIGH PRESSURE STUDIES OF CARBON FULLERITES AND NANOTUBES

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The superhard fullerites have been found after the high pressure (HP) 9.5-13 GPa and high temperature (HT) up to 2100 K treatment of C_{60}. The development of polymerization in high-pressure C_{60} phases is traced from 'soft' dimers to volume superhard polymers. Steps of polymerization rise with the increase of HPHT range. Models of three-dimensional (3D) polymerized structures have been proposed using molecular mechanics methods and refined by the profile analysis of diffractograms. The 3D polymerization of fullerene molecules is realized by a new type of bonding - (3+3) cycloaddition located along the space diagonal of orthorhombic (*Immm*) structures of superhard C_{60} phases. The superhard phase has been observed first 'in situ' at 22.4 GPa in the diamond anvil cell with shear deformation [1]. This phase exists up to 32.7 GPa and at higher pressure a random network of fullerene molecules is formed. The volume bulk modulus of pressure-induced phase (B = 530 ± 80 GPa) determined by its compressibility exceeds that of diamond (B = 441 GPa). The DSC annealing of polymerized phases shows their depolymerization and returns to the molecular structure of C_{60}. The chained structure (C_m) has been determined in C_{70} after HPHT treatment. The new type of fullerene - molecules - bonding is proposed for the chained structure. Single-wall carbon nanotubes have been investigated up to 13 GPa and 1500 K. They are stable up to 13 GPa and 570 K, but there is no polymerization at full HPHT range.

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SUPERCONDUCTIVITY AT HIGH PRESSURE

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We have studied the electrical properties at high pressure such as insulator-to-metal transition and superconductivity on simple systems. Recent developments of high-pressure technique allowed us to searching for superconductivity at Mbar region using DAC (Diamond-Anvil Cell).
We have performed electrical resistance measurements also sensitive magnetization measurements using SQUID magnetometer under high pressure which are the direct proof of superconductivity. Combined condition of pressures above 2 Mbar and temperature down to 30 mK is obtained by assembling the DAC on a 3He/4He dilution refrigerator. The non-magnetic DAC is also useful for the experiment under external field. Electrical resistance measurements are performed by conventional 4-terminal method with thin Pt electrode arranged on the pressure surface of diamond-anvil. Sample is placed directly on the aluminum oxide layer or in the hole on the layer in the case of liquid sample like oxygen.
Examples of pressure-induced superconductors in this report are elemental materials such as iron[1] and sulfur[2]. The results we obtain in these elemental materials may lead us to conclude that almost elements show the superconductivity at some pressures.

References

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HIGH PRESSURE STUDIES AND STRUCTURE OF ELECTRONIC PEROVSKITES

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Perovskites are an important class of materials, characterised by subtle structural distortions from the cubic aristotype structure. The distortions are caused by concerted rotations of the BO_6 octahedra as well as displacements of the A and B cations within the cage. These distortions are temperature and pressure dependent. The distortions give rise to dramatic changes in properties such as dielectric properties, electrical resistivity and band gap. These materials have potential applications in catalysis, magnetic media, electrical conductors and gas sensors.
We present some high pressure and temperature structures of elpasolite perovskites (mixed transition metals on the B site) and correlate these with changes in physical properties. This data allows us to develop structure property relationships allowing us to fine-tune the chemistry to obtain materials with desired properties for the applications mentioned above.

Keywords: PEROVSKITES HIGH PRESSURE HIGH TEMPERATURE