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Flame propagation of LPG-air mixtures in a closed cylindrical vessel

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The dynamics of premixed flame propagation in closed vessels models the burning process in a typical internal combustion engine and represents the initial flame acceleration stage in the development of detonation waves, being an important topic of the combustion science. The explosions occurring in domestic environments or chemical plants are frequent accidental events taking place during storage, transportation and manufacturing of gaseous fuels, failure of chemical and/or petrochemical plants, of high pressure vessels, fuel leaks in buildings or cleaning the fuel tanks. The knowledge of characteristic parameters of these processes allows the assessment of explosion risks for flammable mixtures in various conditions and the design of equipment and industrial plants where they might be formed. The characteristic parameters of explosion propagation in confined conditions are in closed connection with the initial pressure, temperature and concentration of the mixture, the characteristics of the explosion vessel and the position of the ignition source.

In the present paper, the explosions of gaseous LPG-air mixtures with various LPG concentrations between the flammability limits and initial pressures between 0.20 and 1.50 bar were experimentally investigated at ambient initial temperature, using a cylindrical vessel with 1.5 length to diameter ratio. The ignition, made by inductive-capacitive electric sparks, took place in the geometrical center or near vessel's bottom.

For centrally ignited explosions, linear correlations were found for the peak explosion pressures and the maximum rates of pressure rise against initial pressure. The intercepts of linear correlations pmax = f(p0) are relevant for the amount of heat transferred to the explosion vessel before the end of combustion, depending on vessel's asymmetry. The comparison between experimental and adiabatic explosion pressures afforded the estimation of heat losses appearing in the last stage of explosions, strongly influenced by the ignition source position, initial concentration and pressure of flammable mixtures.

Recent Publications

1.C. Movileanu, V. Giurcan, M. Mitu, D. Razus, D. Oancea, Ignition by Low-Voltage Electric Discharges of Diluted and Undiluted C3H8−Air Mixtures, Ind. Eng. Chem. Res. 2021, 60, 12123−12132.

2.C. Movileanu, M. Mitu, V. Giurcan, D. Razus, D. Oancea, Quenching distances, minimum ignition energies and related properties of propane-air-diluent mixtures, Fuel, 274, 2020, 117836.

3.Razus, D., Movileanu, C., Oancea, D., Additive influence on ignition of stoichiometric ethylene-air mixture by break sparks, Fuel 232, 134-140, 2018

Biography

Codina Movileanu has her expertise in chemical kinetics in homogeneous and heterogeneous systems, combustion and flames of gases, flammability of gaseous mixtures in air, safety recommendations, for closed and open systems where deflagrations may occur. Available experimental techniques: methods for measuring the ignition and propagation parameters characteristic for gaseous fuel-oxidant mixtures (flammability limits; minimum ignition energy, for initiation with high-voltage or low-voltage electric sparks or with heated wires; peak pressure, maximum rate of pressure rise, deflagration index of closed vessel explosions; propagation speed and normal burning velocity). Main research directions: critical conditions for explosion initiation by means of electric sparks or hot bodies (metallic wires, jets of hot, burned gas); flammability limits; flame propagation in hydrocarbon-oxygen and hydrocarbon-air mixtures, in steady and non-steady conditions.

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Mechanical and electronic properties of al(111)/6h-sic interfaces: A dft study

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A density functional theory (DFT) calculation is carried out in this work to investigate the effect of vacancies on the behavior of Al(1 1 1)/6H SiC composites. DFT simulations with appropriate interface models can be an acceptable alternative approach to experimental. We developed two modes for Al/SiC superlattices, C-terminated and Si-terminated interface configurations. The results illustrate that C and Si vacancies are challenging to generate, while Al vacancies near the interface are easy to generate. C and Si vacancies reduce interfacial adhesion energy significantly, while Al vacancies close the interface have little effect on the adhesion energy. Young's modulus (E) is higher for C-terminated configurations than for Si-terminated configurations. Supercells are stretched vertically along the Z-direction to obtain tensile strength. The tensile properties show that failure usually occurs not at the interface but near the Al side. The existence of C and Si vacancies noticeably increases the tensile properties of the composite, particularly C and Si vacancies at the interface. According to the results, SiC and Al interfaces with C-terminated have better bonding properties. Furthermore, we systematically studied the surface energies (γ) and mode one fracture toughness (KIC). Finally, densities of states (DOS) were calculated to understand these systems' electronic properties better.

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2. Masoud Tahani , Eligiusz Postek , and Tomasz Sadowski. Molecular Dynamics Study of Interdiffusion for Cubic and Hexagonal SiC/Al Interfaces. Crystals 2023, 13, 46

3. Qingjie Wu, Jingpei Xie, Aiqin Wang, Douqin Ma, Chang Wang. First-principal calculations on the structure of 6H-SiC/Al interface. 2019 Materials Research Express 6 065015.

4. Kuiying Chen, Mariusz Bielawski. Ab initio study on fracture toughness of Ti0.75X0.25C ceramics. Journal of Materials Science (2007) 42:9713–9716.

5. Zhi-Gang Mei, Sumit Bhattacharya, Abdellatif M. Yacout. First-principles study of fracture toughness enhancement in transition metal nitrides. Surface & Coatings Technology 357 (2019) 903–909.

Biography

Mostafa Fathalian, obtain a master's degree from Semnan University in 2017. He has a good background in manufacturing composites and nanocomposites. He collaborated with Prof. Ghorbanzadeh at Mazandaran University as a researcher. He published 5 papers in the journals of Fib &Pol, Vacuum, App Surf Sci, Phys E & Mater Chem & Phys. He also has a patent in the field of nanocomposite.

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